



DRAFT

*Feasibility Study
Willamette Cove Upland Facility
Portland, Oregon*

Prepared for:
Port of Portland

February 12, 2014
1056-04



DRAFT

***Feasibility Study
Willamette Cove Upland Facility
Portland, Oregon***

Prepared for:
Port of Portland

February 12, 2014
1056-04

DRAFT

*Michael Pickering, R.G.
Senior Associate Hydrogeologist*

DRAFT

*Herb Clough, P.E.
Principal Engineer*

Table of Contents

1.0 INTRODUCTION	1
1.1 Purpose	1
1.2 Report Organization	1
2.0 BACKGROUND	2
2.1 Site Description	2
2.2 Historical Site Use	3
2.3 Current Site Use	4
2.4 Future Site Use.....	5
2.5 Soil Conditions.....	6
2.6 Groundwater Conditions.....	6
2.7 Surface Water Conditions.....	6
2.8 Upland Investigations and Chemicals of Concern	7
2.9 Source Control Evaluation	8
3.0 SUMMARY OF BASELINE RISK ASSESSMENT	9
3.1 Ecological Risk Assessment.....	9
3.2 Human Health Risk Assessment	10
4.0 SITE MODEL	13
4.1 Nature and Extent of Contamination.....	13
4.2 Existing Conditions	14
4.3 Site Use	14
4.4 Coordination with Other Portland Harbor Activities	15
5.0 REMEDIAL ACTION OBJECTIVES AND EVALUATION CRITERIA.....	15
5.1 Remedial Action Objectives.....	15
5.1.1 Ecological	15
5.1.2 Human Health.....	16
5.2 Evaluation Criteria	16
6.0 REMEDIAL ACTION AREA AND EXTENT.....	17
7.0 REMEDIAL ACTION ALTERNATIVES AND PRELIMINARY SCREENING	18
7.1 Technology Screening.....	19
7.2 Development of Cleanup Action Alternatives	20
8.0 DETAILED ANALYSIS OF REMEDIAL ACTION ALTERNATIVES	22
8.1 No Action	22
8.2 Cap.....	22
8.3 Excavation and Off-Site Disposal	25
8.4 Excavation and On-Site Disposal	27
8.5 Focused Excavation and Off-Site Disposal with Cap	30

Table of Contents (continued)

8.6 Focused Excavation and Off-Site Disposal with Alternate Cap and Access Restriction	32
8.7 Alternate Cap and Access Restriction	35
9.0 COMPARATIVE EVALUATION OF REMEDIAL ACTION ALTERNATIVES.....	38
9.1 Protectiveness	38
9.2 Effectiveness	38
9.3 Long-Term Reliability.....	38
9.4 Implementability.....	38
9.5 Implementation Risk	39
9.6 Reasonableness of Cost	39
9.7 Treatment or Removal of Hot Spots	39
10.0 RECOMMENDATION	40
10.1 Recommended Remedial Action Alternative: Focused Excavation and Offsite Disposal with Alternate Cap and Access Restriction	40
10.2 Permit or Permit Exemption Requirements	40
10.3 Residual Risk Assessment	40
11.0 REFERENCES	47

Tables

1	Preliminary Remediation Goals for Ecological Receptors
2	Preliminary Remediation Goals for Human Receptors
3	Initial Screening and Evaluation of Technologies for Soil
4	Cost Table – Cap
5	Cost Table – Excavation and Off-Site Disposal
6	Cost Table – Excavation and On-Site Disposal
7	Cost Table – Focused Excavation and Off-Site Disposal with Cap
8	Cost Table – Focused Excavation and Off-Site Disposal with Alternate Cap and Access Restriction
9	Cost Table – Alternate Cap and Access Restriction
10	Comparative Evaluation of Alternatives

Figures

1	Facility Location Map
2	Facility Plan
3	Soil Sample Locations
4	Riverbank Sample Locations

Figures (continued)

- 5 Additional Riverbank Sample Locations
- 6 Ecological Risk and Hot Spot Areas
- 7 Human Health Risk and Hot Spot Areas
- 8 Summary Cleanup and Hot Spot Areas
- 9 Remedial Action Area – Cap or Excavation and Off-Site Disposal
- 10 Typical Cap Cross Sections
- 11 Riverbank Typical Sections
- 12 Remedial Action Area – Excavation and On-Site Disposal
- 13 Remedial Action Area – Focused Excavation and Off-Site Disposal with Cap
- 14 Remedial Action Area – Focused Excavation and Off-Site Disposal with Alternate Cap and Access Restriction
- 15 Remedial Action Area – Alternate Cap and Access Restriction

Appendices

- A Major Vegetation Communities at Willamette Cove
- B Chemical Data in Soil (CD-ROM)
- C Exceedances of Preliminary Remediation Goals and Hot Spot Levels (CD-ROM)
- D Residual Risk Tables

Abbreviations/Acronyms

ARL	Acceptable Risk Level
BaP	Benzo(a)pyrene
bgs	Below the Ground Surface
BNSF	Burlington Northern Santa Fe
cfs	Cubic Feet Per Second
COCs	Chemicals of Concern
COPCs	Chemicals of Potential Concern
cy	Cubic Yards
DEQ	Oregon Department of Environmental Quality
ECSI	Environmental Cleanup Site Information
ELCR	Excess Lifetime Cancer Risk
EPA	U.S. Environmental Protection Agency
Facility	Willamette Cove Upland Facility
FS	Feasibility Study
HPAHs	High Molecular Weight Polycyclic Aromatic Hydrocarbons
LOAEL	Lowest Observed Adverse Effects Level
Mg/kg	Milligrams per Kilogram
Msl	Mean Sea Level
NAPL	Non-Aqueous Phase Liquid
NPV	Net Present Value
OS	Open Space
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PDC	Portland Development Commission
Port	Port of Portland
PRGs	Preliminary Remediation Goals
RAOs	Remedial Action Objectives
RERA	Residual Ecological Risk Assessment
RHHRA	Residual Human Health Risk Assessment
RI	Remedial Investigation
TQ	Toxicity Quotients
sf	Square Feet
SMP	Soil Management Plan
SVOCs	Semi-Volatile Organic Compounds
UPRR	Union Pacific Railroad
VCP Agreement	Voluntary Cleanup Program Agreement

1.0 Introduction

This report presents the feasibility study (FS) for the Willamette Cove Upland Facility (the Facility). The FS is being performed as part of Voluntary Cleanup Agreement EC-NWR-00-26 (VCP Agreement) between the Port of Portland (Port), Metro, and the Oregon Department of Environmental Quality (DEQ). The Facility is defined in the DEQ Environmental Cleanup Site Information (ECSI) database as ECSI No. 2066.

1.1 Purpose

The purpose of the FS is to evaluate remedial options and recommend a remedial alternative that addresses the unacceptable baseline risk identified in the Residual Ecological Risk Assessment (RERA; Formation, 2014) and the Residual Human Health Risk Assessment (RHHRA; Formation, 2013) in accordance with the requirements of DEQ rules and guidance.

1.2 Report Organization

The following is a brief overview of the organization of the report.

Site Background. Section 2 describes the Facility; site history; current conditions and proposed uses; soil, groundwater, and surface water; and previous environmental investigations and actions.

Risk Assessment Summary. Section 3 summarizes the results of the ecological and human health residual risk assessments. The summary identifies areas that are above acceptable risk levels and high concentration hot spot levels.

Site Model. The information from Sections 2 and 3 is synthesized in Section 4 to identify the key information needed to complete the FS. This summary includes the nature and extent of contaminants, existing conditions, presumed future site use, and coordination requirements for other Portland Harbor cleanup activities.

Remedial Action Objectives and Remedial Action Area. Section 5 defines and discusses the appropriate remedial action objectives (RAOs) for Willamette Cove and the criteria by which potential remedial action alternatives will be evaluated. The extent of the areas that exceed acceptable baseline risk levels or hot spot levels are described in Section 6.

Technology Evaluation and Remedial Action Alternatives. A list of general response actions are developed and presented in Section 7 to address the conditions encountered in the remedial action areas described in Section 6. These general response actions form the basis for generating and screening technologies. Potential remedial technologies were developed for each general response action identified.

Technologies were then evaluated with respect to specific site conditions, waste characteristics, and the ability to achieve the RAOs. The technologies remaining after the screening process were then combined to create potential alternatives for further detailed analysis.

Detailed Analysis of Remedial Alternatives. The potentially feasible remedial action alternatives are more fully developed in Section 8. The protective alternatives are evaluated on the basis of the balancing factors (effectiveness; long-term reliability; implementability; implementation risk; and reasonableness of cost) and the degree to which the alternative addresses removal or treatment of hot spots. The evaluation includes sufficient detail to identify comparative or relative differences among alternatives.

Comparative Evaluation of Remedial Action Alternatives and Recommendation. After completion of the detailed screening, the feasible remedial alternatives are ranked on the basis of a comparative analysis within the balancing factors in Section 9. Based on the results of the comparison rankings, a remedial action alternative is recommended. The recommended remedial action alternative is discussed in Section 10.

2.0 Background

2.1 Site Description

The Facility is located along the northeast bank of the Willamette River in the St. Johns area of Portland, Oregon. Figure 1 shows the location of the Facility. The Facility is situated between River Miles 6 and 7 on the Willamette River and is mostly in Section 12 of Township 1 North, Range 1 West, Willamette Meridian. The Facility has been owned by Metro since 1996. Figure 2 provides a current plan of the Facility as well as the surrounding area. For purposes of describing the Facility, it has been divided into West, Central, and East Parcels as shown on Figure 2.

Extent of the Upland Facility. The Facility as defined in the VCP Agreement covers approximately 24 acres of upland area that is inland from the mean high water line (defined as 13.3 feet, NAVD88 datum) to the Union Pacific Railroad (UPRR). The upland portion is approximately 3,000 feet long and varies from 150 to 700 feet in width. The cove is set in up to 800 feet from the main river channel; it was created primarily as a result of the placement of the embankment leading up to the railroad bridge.

Access. The Facility is accessible by vehicle either from North Edgewater Street (for the east end) or North Richmond Avenue (for the west end). A locked gate is present at the north end of North Edgewater Street one block south of its intersection with North Willamette Boulevard. Unimproved roadways are present on the Central and East Parcels but vehicle access is limited by concrete blocks/rubble at multiple locations. Access to the area by foot or from the river is possible.

Structures and Improvements. There are no structures on the Facility. Indications of previous structures include a large concrete foundation and a paved roadway in the eastern portion of the Facility, several smaller concrete structures or foundations, and structural piling within the cove and along the riverbank. Riprap is present along much of the riverbank.

Topography. The Facility is situated on a terrace created by historical filling. Overall, the topography of this terrace is flat, with an elevation ranging between 30 and 45 feet above mean sea level (msl, NAVD88). The southern portion of the West Parcel is slightly higher, at 50 to 55 feet msl. Berms and hummocks are occasionally present. The riverbank is generally a steep 20- to 30-foot slope down to the river. The river water elevation is typically less than 10 feet msl and is subject to a mean tidal range of about 2 feet.

The Burlington Northern Santa Fe (BNSF) railroad embankment along the southeast perimeter of Willamette Cove rises steeply about 50 feet above the cove. North of the property, across the UPRR tracks, is a naturally formed 120- to 150-foot-high bluff. By the Central and East Parcels, this bluff rises at approximately 5H:4V. Near the West Parcel, the slope is approximately 10H:3V.

Vegetation. A future development planning document (Alta Planning and Design, 2010) summarizes results from a natural resource assessment of the Facility completed in 1999. Appendix A includes a figure excerpted from the report showing the major vegetation communities on the Facility.

Surrounding Properties. The Facility is bordered on the northeast by the UPRR tracks. Farther to the northeast is a vegetated bluff. A residential area is present on top of the bluff and farther inland. Bordering the northwest side of the Facility is a vacated portion of North Richmond Avenue. To the southeast is an embankment for a railroad bridge over the Willamette River for the BNSF railroad. On the opposite side of this embankment is the former McCormick & Baxter Creosoting Company, a federal Superfund Site. The southern portion of the East Parcel of the Facility has been impacted by a contaminant plume (including polycyclic aromatic hydrocarbons [PAHs], semi-volatile organic compounds [SVOCs], dioxins/furans, arsenic, chromium, copper, zinc, pentachlorophenol, and non-aqueous phase liquids [NAPL]) emanating from the McCormick & Baxter Creosoting Company Superfund Site. The McCormick & Baxter contaminant plume has migrated northwestward from McCormick & Baxter's former wood treatment operations, under the railroad embankment, and has emerged in the sediments of Willamette Cove. DEQ, acting on behalf of the U.S. Environmental Protection Agency (EPA), has implemented a remedial action consisting of a subsurface barrier wall and sediment cap to address the McCormick & Baxter contaminant plumes and NAPL seeps in Willamette Cove.

2.2 Historical Site Use

West Parcel. The West Parcel was originally developed in 1901 as a plywood mill, and operated as a wood products facility into the 1970s. The property was purchased by the Portland Development Commission

(PDC) in 1979. The property has remained vacant since. In 1996, the property was sold to Metro for the purpose of creating a green space area to be used as a public park.

Central Parcel. The Central Parcel was developed in 1903 in conjunction with the construction of the St. Johns Dry Docks in Willamette Cove. Between 1903 and 1924, shops and ancillary structures that provided support for dry dock activities were constructed. The dry docks were closed in 1953. The western portion of the Central Parcel was sold in 1950 and it was incorporated into the plywood and lumber mill operations on the adjacent West Parcel. The remainder of the Central Parcel was sold in 1953 and developed as a sawmill. By 1970, the sawmill was no longer in use. Up until 1981, portions of the property were used for a variety of purposes such as log rafting, a marine salvage company, a demolition contractor, woodworking facilities, and a boat builder. By 1981, the property was purchased by PDC, and PDC demolished the buildings by 1982. The property has remained vacant since. In 1996, the property was sold to Metro for the purpose of creating a green space area to be used as a public park.

East Parcel. The East Parcel was historically occupied by a cooperage plant (i.e., wood barrel manufacturer) from 1915 until the 1950s (when declining demand led to a focus on plywood production). Until 1980, a variety of wood-product-related businesses occupied the parcel. PDC purchased the property in 1980 and demolished the buildings by 1982. The property has remained vacant since. In 1996, the property was sold to Metro for the purpose of creating a green space area to be used as a public park.

2.3 Current Site Use

The Facility is currently vacant, covered with invasive and native vegetation, and provides habitat for opportunistic use by wildlife. The site is not managed for any human use and is posted to prohibit trespassing. However, trespassers do come on the site (e.g., homeless persons and joggers).

The Facility is currently zoned as an Open Space (OS) zone with “g” (River General) and “q” (River Water Quality) greenway overlay zones (City of Portland, 2004). The Open Space zone is intended to preserve and enhance public and private open, natural, and improved park and recreational areas. Greenway regulations are also intended to protect, conserve, enhance, and maintain the natural, scenic, historical, economic, and recreational qualities of lands along Portland’s rivers. Specifically, the “g” overlay is intended to allow public use and enjoyment of the waterfront and for enhancement of the river’s scenic and natural qualities. The “q” overlay is designed to protect the functional values of water quality resources by limiting or mitigating the impact of development in the 25-foot setback from the top of bank. Other nearby zoning includes commercial (EG2), residential (R2 and R5), open space (OS), and industrial (IH and IG2; City of Portland, 2004).

The Facility is included in a citywide inventory that identified scenic resources (City of Portland, 2012). The Facility is identified as a scenic viewpoint. The zoning map shows a multi-use trail through the Facility (City

of Portland, 2004). However, this trail is only proposed as part of the regional trail plan adopted by Metro (Alta Planning and Design, 2010) – see further discussion in Section 2.4.

2.4 Future Site Use

Portland Parks and Recreation prepared a draft management plan for the Facility (City of Portland, 1999). That report indicated that one potential plan for the Facility would be a park featuring urban natural areas with passive recreation opportunities. The plan includes a “Cottonwood Forest” zone in the East Parcel that would have clusters of large trees, a natural resources education area for children, a rustic picnic area (see further discussion below), bird watching opportunities, and a parking lot for up to 40 vehicles. The Portland Bureau of Parks and Recreation has also identified the need for a park in this area, listing both Willamette Cove and the McCormick & Baxter Superfund Facility as potential locations for natural areas, river access, and recreation (City of Portland, 2001).

In addition, the current understanding of proposed future development of the trail and natural areas in a future park at Willamette Cove is summarized below from the Trail Alignment Refinement Report (Alta Planning & Design, 2010), modified based on discussions with Metro.

- The Facility “presents a significant open space opportunity along the riverfront.”
- The zoning allows for “public use and enjoyment of the waterfront” that “enhance the river’s natural and scenic qualities” but also requires uses that “protect the functional values of water quality resources by limiting or mitigating the impact of development.”
- The City’s draft North Reach River Plan indicates that the Facility is considered a potential mitigation site and allows “ecologically sensitive” trails to the river.
- Metro and the City are developing a restoration plan that focuses on restoration of the Oregon white oak and madrone plant communities on the Facility.
- The paved trail would be developed on existing open corridors through the Facility. It would be 12 feet wide with 2-foot shoulders.
- Viewing platforms and/or soft surface trails to the water’s edge could be strategically placed to control use of the site and to view scenery or wildlife.

As the property owner, Metro recognizes that the presence of hazardous substances may limit the use of the property. Therefore, Metro will agree to place restrictions on the property deeds that limit site uses to passive recreation activities (including but not limited to trails, benches, viewing areas, in-water mitigation sites, and not active uses such as designated child play areas, sports fields, or picnic areas).

2.5 Soil Conditions

The geology beneath the Facility consists of fill and alluvial deposits. Early maps of the area indicate the current upland portion of the facility consisted of a strip of lowland adjacent to the current UPRR railroad tracks. Based on historical maps and photographs, fill was placed on this lowland and outward into the Willamette River prior to and concurrent with development. The thickness of the fill across the Facility likely varies from about 20 to 30 feet; however, in places, it could be up to 60 feet (such as in a former log pond on the West Parcel filled in the early 1970s).

The fill and alluvial deposits consist of silts and sands. These units are often distinguished from natural deposits based only on historical topographic maps and the presence of anthropogenic debris in the fill. Debris encountered in explorations at the Facility consisted mostly of bricks, metal, and wood, with lesser amounts of glass, asphalt concrete, and Portland cement concrete. In the West Parcel, debris is only present along the southern half (riverside) of the parcel at depths of up to 35 feet. In the Central Parcel, debris was present between 12 and 27 feet below the ground surface (bgs) in the western half of the parcel (surficial debris was on the east half). In the East Parcel, debris was present only along the southeast perimeter, at depths of up to 15 feet (Hart Crowser, 2003).

2.6 Groundwater Conditions

Shallow groundwater at the Facility was measured in monitoring wells to range in depth from 23 to 37 feet bgs. Groundwater elevations ranged from 7.2 to 21.5 feet (NAVD88). Groundwater levels are expected to seasonally fluctuate in response to both precipitation and river levels, with lower groundwater elevations expected during the summer and fall. The groundwater gradient beneath the Facility is anticipated to be toward the Willamette River.

2.7 Surface Water Conditions

There are no surface water features or storm drains on the Facility. Precipitation either infiltrates or runs off via sheet flow.

The Willamette River is the only surface water body near the Facility. The Facility is located between River Miles 6 and 7 on the Willamette River. Along this reach, the river flows to the northwest and is about 1,500 feet wide. In Portland, the river flows at a rate ranging from 8,300 cubic feet per second (cfs) in summer to 73,000 cfs in winter. The elevation of the 100-year floodplain along this reach is about 28 feet msl, and the elevation of the 500-year floodplain is about 32 feet msl. Above the top of slope along the river, the ground surface elevation is between 30 and 40 feet msl.

2.8 Upland Investigations and Chemicals of Concern

Numerous investigations, assessments, and environmental actions have been performed at the Facility since 1988. The following sections summarize the scope and results of work performed that are relevant to the FS. Sample locations are shown on Figures 3 through 5. Data relevant to the FS are listed in the tables in Appendix B.

2.8.1 Remedial Investigation Soil Sampling

The Port and Metro conducted a remedial investigation (RI) of the Facility between April 2001 and September 2002. The RI activities included completing 26 test pits, 30 direct-push soil borings, and seven hand-augered soil borings; and collecting 35 surface soil samples. The results of the RI and historical investigations were presented in the RI Report (Hart Crowser, 2003). Soil data from the RI are included in a spreadsheet database (on compact disk) in Appendix B.

2.8.2 Riverbank Sampling

DEQ provided comments on the RI Report in a letter dated December 20, 2003. Several of these comments expressed concern regarding potentially erodible soil on the riverbank at the Facility. In response to these comments and additional comments received from DEQ in meetings on June 22, 2005 and October 17, 2005, the Port and Metro completed riverbank sampling. The purpose of that work was to assess for the presence and magnitude of polychlorinated biphenyls (PCBs), PAHs, and metals in potentially erodible riverbank soil for evaluating source control for the Facility.

The results of the first phase of riverbank sampling were presented in the *Riverbank Soil Sampling Report* (BBL/Ash Creek/NF, 2006). That report presents results for samples WC-SSA through WC-SSK. These data are included in a spreadsheet database in Appendix B.

The Port and Metro conducted sampling to assess the lateral extent of PCBs in the riverbank at the boundary between the East and Central Parcels. The sampling results for additional surface soil samples (WC-SSH-A through WC-SSH-H, WC-SSH-SHS1, and WC-SSH-SHS2) were presented in the *Addendum to Riverbank Soil Sampling Results Report* (Ash Creek/NewFields, 2008). These data are included in a spreadsheet database in Appendix B.

In 2010, additional riverbank sampling was completed. Sample results (WC-SSL through WC-SSY and WC-1 through WC-3) are presented in the *2010 Source Control Sampling Results* (Ash Creek, 2011). These data are included in a spreadsheet database in Appendix B.

Follow-up sampling of soil in the vicinity of the former wharf road was completed in 2012. Sample results (DU-1, DU-2, and DU-3) are presented in the *Surface Soil Sampling Results — Former Wharf Road Area* (Ash Creek, 2012). These data are included in a spreadsheet database in Appendix B.

2.8.3 Chemicals of Potential Concern

A screening of the chemical data was completed to identify chemicals of potential concern (COPCs). In general, the screening process used assumptions about exposure and toxicity that are more conservative than used in the subsequent risk calculations. This approach assures that chemicals that may contribute small but significant portions to overall risk are not left out. The COPC screening identified the following chemicals detected at least once in soil above screening levels in the upland exposure units.

COPC	Ecological	Human Health
Antimony	X	X
Arsenic		X
Cadmium		X
Chromium	X	
Copper	X	X
Lead	X	X
Mercury	X	X
Nickel	X	
Zinc	X	
PCBs	X	X
Dioxins	X	X
TPH	X	X
PAHs	X	X

2.9 Source Control Evaluation

A source control evaluation was completed for the Facility (Apex, 2013) and riverbank erosion and groundwater were identified as potential pathways for contaminant transport to the Willamette River. Each pathway was evaluated with the following results.

Riverbank Erosion. The Facility riverbank is approximately 3,500 feet long. Approximately 2,900 feet of the riverbank was determined to be either excluded from need for source control or to be low priority for source control. Areas were excluded because there is no current or reasonably likely complete contaminant pathway to the river. Areas were determined to be low priority because either ERs in riverbank soil were less than three or multiple lines of evidence supported that there is a low potential for that area to contaminate the river. Three areas totaling 560 feet in length were found to be medium priority, summarized as follows.

- 240 feet of bank on the Central Parcel in the vicinity of the WC-SSV sample location – This area has relatively greater visual evidence of erosion, and riverbank soil contains lead, copper, and mercury in the range of 10 to 100 times the screening levels.

- 170 feet of bank on the Central Parcel in the vicinity of the former Wharf Road – This area has relatively lesser visual evidence of erosion, but riverbank soil contains dioxins/furans, mercury, and lead in the range of 40 to 500,000 times the screening levels.
- 150 feet of bank on the East Parcel in the vicinity of the WC-SSH sample location – This area has relatively lesser visual evidence of erosion, but riverbank soil contains PCBs at up to 4,700 times the screening level.

Based on multiple lines of evidence, the short-term potential for transport of riverbank soils from these areas to the river is low. Therefore, it was recommended that source control for the medium priority riverbank areas be incorporated into the final remedy for the in-water cleanup.

Groundwater. Groundwater was identified as a low priority for source control and no further source control efforts were recommended.

3.0 Summary of Baseline Risk Assessment

For the purpose of evaluating baseline risk, the Facility was divided into six exposure units. Two of these units, Central Beach Unit and Inner Cove Beach Unit, are not on the Facility. Baseline risks, if any, for these two units will be addressed by the in-water cleanup actions and are not the subject of this FS. Baseline risk for the other four units – West Parcel, Central Parcel, East Parcel, and former Wharf Road (dioxins only) – is summarized below.

3.1 Ecological Risk Assessment

A Level II Screening RERA was completed for the Facility (Formation, 2014). Based on the results presented in this RERA, ecological receptors at the Facility could experience toxic exposures to chemicals of concern (COCs) if they spend enough time in areas of the highest concentrations. Figures in Appendix C show the locations of soil samples exceeding ecological Preliminary Remediation Goals (PRGs) for each COC. Ecological PRGs and high concentration hot spot levels determined in the risk assessment are listed in Table 1. A summary of the potential baseline risks for each exposure unit is provided below.

3.1.1 West Parcel

PCBs, high molecular weight PAHs (HPAHs), and mercury were each detected in one sample on the West Parcel above corresponding PRGs. PCBs and HPAHs exceeded PRGs by a factor of 10 percent, so the overall risk to populations is expected to be acceptable. Mercury exceeded the PRG by a factor of 12, so this location is a high concentration hot spot. Figure 6 shows the location of the ecological cleanup areas and high concentration hot spots on the West Parcel.

3.1.2 Central Parcel

On the Central Parcel, metals (antimony, chromium, copper, lead, mercury, nickel, and zinc), PCBs, and HPAHs were detected above their respective PRGs, and antimony, copper, lead, mercury, and zinc were detected at least once above high concentration hot spot levels. Chromium, nickel, and PCBs were detected above PRGs infrequently (one, six, and two samples, respectively), and the maximum PRG exceedance was less than three times. In areas where COCs were detected above PRGs but below hot spot levels, on average the PRG is exceeded by factors of 2 to 4 times. Figure 6 shows the location of the ecological cleanup areas and high concentration hot spots on the Central Parcel.

3.1.3 East Parcel

On the East Parcel, metals (antimony, chromium, copper, lead, mercury, nickel, and zinc) and PCBs were detected above their respective PRGs, and antimony, copper, lead, zinc, and PCBs were detected at least once above high concentration hot spot levels. Chromium and mercury were each detected above PRGs only once each at concentrations exceeding the PRG of 2 and 4 times, respectively, and the samples exceeding PRGs are located in areas that were identified as high concentration hot spots for other COCs. Outside of areas with COCs detected above hot spot levels, only nickel and zinc were detected once each above PRGs, and the PRGs were exceeded by less than 10 percent. Outside of the hot spot areas, ecological risks on the East Parcel are acceptable. Figure 6 shows the location of the ecological cleanup areas and high concentration hot spots on the East Parcel.

3.1.4 Former Wharf Road

Composite samples representing the former Wharf Road unit each had dioxin concentrations that exceed the PRGs and high concentration hot spot levels. Figure 6 shows the location of the ecological cleanup areas and high concentration hot spots on the former Wharf Road unit.

3.2 Human Health Risk Assessment

Human health baseline risks are summarized below for each exposure unit from the results of the RHHRA (Formation, 2013). The following receptors were evaluated for baseline risk:

- Transient Trespasser (current);
- On-Site Construction Worker (future); and
- Recreational Trespasser (current)/Park User (future).

Figures in Appendix C show the locations of soil samples exceeding human health PRGs for each COC. Human health PRGs and high concentration hot spot levels determined in the risk assessment are listed in Table 2.

3.2.1 West Parcel

Risks are acceptable for the Transient Trespasser and the Construction Worker. Unacceptable baseline risk was identified for the Recreational Trespasser for two PAHs, with the majority of the risk resulting from benzo(a)pyrene (BaP). No human health high concentration hot spots were identified on the West Parcel. Figure 7 shows the location of the human health cleanup areas on the West Parcel.

3.2.2 Central Parcel

Baseline risks for the Transient Trespasser are acceptable. Unacceptable baseline risks were identified for the Recreational Trespasser/Future Park User and the Construction Worker, as summarized below. Figure 7 shows the location of the human health cleanup areas and high concentration hot spots on the Central Parcel.

Recreational Trespasser/Future Park User. Total excess lifetime cancer risk (ELCR) for the Recreational Trespasser was $2\text{E-}4$, which exceeds the Oregon acceptable risk level (ARL) for multiple chemicals (i.e., $1\text{E-}5$). Carcinogenic risk was primarily from PAHs. Multiple PAHs exceeded the ARL for individual chemicals. Concentrations of BaP above high concentration hot spot levels are present at two locations on the Central Parcel. Risk from arsenic ingestion also exceeded the ARL for individual chemicals, but the arsenic concentrations in soil (2 to 40 milligrams per kilogram [mg/kg]) are similar to the default background concentration (8.8 mg/kg). Of the 16 samples that exceeded the default background concentration for arsenic, 12 are located in an area identified as an ecological or human health high concentration hot spot based on the presence of other chemicals.

Non-cancer risks exceeded the ARL for multiple chemicals ($\text{HI} = 1.3$). No individual chemicals had a HQ of 1 or higher.

Construction Worker. Estimates of ELCR for this scenario did not exceed the Oregon ARL for multiple chemicals, but the risk estimates for BaP exceeded the ARL for individual chemicals.

Non-cancer risks exceeded the ARL for multiple chemicals ($\text{HI} = 1.5$). Lead was the only chemical with an HQ of 1 or higher. Of the 14 samples that exceeded the PRG for lead, 11 are located in an area identified as an ecological or human health high concentration hot spot based on the presence of other chemicals or receptors.

3.2.3 East Parcel

Unacceptable baseline risks were identified for the Transient Trespasser, Recreational Trespasser/Future Park User, and the Construction Worker, as summarized below. No human health high concentration hot

spots were identified on the East Parcel. Figure 7 shows the location of the human health cleanup areas on the East Parcel.

Transient Trespasser. Total ELCR for the Transient Trespasser did not exceed the Oregon ARL for multiple chemicals, and no cancer risks exceeded the ARL for individual chemicals.

Non-cancer risks exceeded the ARL for multiple chemicals (HI = 2.0), but no individual chemicals had HQs higher than 1. The HQs contributing most to the HI were for lead, antimony, and copper. The samples contributing most to the unacceptable risk are located along the BNSF railroad embankment in an area identified as an ecological or human health high concentration hot spot based on the presence of other chemicals or receptors.

Recreational Trespasser/Future Park User. Total ELCR for the Recreational Trespasser was $3E-5$, which exceeds the Oregon ARL for multiple chemicals (i.e., $1E-5$). Carcinogenic risk was primarily from BaP, arsenic, and PCBs, each of which exceed the ARL for individual chemicals.

Non-cancer risk for copper (ingestion) and antimony (dermal) were equal to or greater than the ARL for the child receptor, and the HI for all COPCs and pathways was 6.7, with lead and PCBs contributing to the overall risk level for the child receptor. HQs for the adult were less than 1, and the HI was also less than 1. The samples contributing most to the unacceptable risk are located along the BNSF railroad embankment in an area identified as an ecological or human health high concentration hot spot.

Construction Worker. Estimates of ELCR for this scenario did not exceed the Oregon ARL for multiple chemicals or individual chemicals.

Non-cancer risks exceeded the ARL for multiple chemicals (HI = 5.8) with lead and antimony as the only COPCs with individual HQs of 1 or higher. The samples contributing to the unacceptable risk are located along the BNSF railroad embankment in an area identified as an ecological or human health high concentration hot spot.

3.2.4 Former Wharf Road

Unacceptable baseline risks were identified for the Transient Trespasser, Recreational Trespasser/Future Park User, and the Construction Worker, as summarized below. Figure 7 shows the location of the human health cleanup areas on the former Wharf Road unit.

Transient Trespasser. Total ELCR for the Transient Trespasser was $2E-6$, which exceeds the Oregon ARL for individual chemicals, but does not exceed the ARL for multiple chemicals. Non-cancer risks did not exceed the ARL (HQ = 0.8).

Recreational Trespasser/Future Park User. Total ELCR for the Recreational Trespasser was $4\text{E-}5$, which exceeds the Oregon ARL for individual and multiple chemicals. Non-cancer risk also exceeded the ARL with a HQ of 3.7.

Construction Worker. Total ELCR for this receptor was $4\text{E-}6$, which exceeds the Oregon ARL for individual chemicals. Non-cancer risk also exceeded the ARL with a HQ of 2.9.

4.0 Site Model

Based on the information summarized in Sections 2 and 3, this section presents the overall site model that is the basis for the evaluations completed in the FS.

4.1 Nature and Extent of Contamination

This section summarizes the nature and extent of contamination on the Facility as it relates to potential risk and the potential receptors. Figure 8 summarizes the location of potential cleanup areas and hot spot areas, identifying the extent, receptor, and COC. The various areas shown on the figure were determined by defining each locus of sampling points where soil data exceeded a PRG corresponding to an unacceptable baseline risk pathway. The data are included in a spreadsheet database in Appendix B and the PRGs are shown in Tables 1 and 2.

4.1.1 West Parcel

Except for a small area where mercury is present above the high concentration hot spot level, ecological risk is acceptable on the West Parcel.

Baseline human health risk is acceptable on the West Parcel for short-term or passive uses (e.g., construction, transient visitors, animal watching). For more active uses such as picnicking or athletics, baseline risks are unacceptable as a result of PAHs in surface soil (0 to 3 feet in depth).

4.1.2 Central Parcel/Former Wharf Road

Ecological receptors on the Central Parcel could experience toxic exposures to dioxins, metals, and PAHs in surface soil if they spend enough time in areas of the highest concentrations. Seven areas have concentrations of metals and/or dioxins above high concentration hot spot levels. Outside of these hot spot areas, there are two areas where COCs were detected above PRGs. On average in these two areas, concentrations exceed the PRGs by factors of 2 to 4.

Baseline human health risk is unacceptable on the Central Parcel primarily as a result of PAHs, lead (construction worker only), and dioxins in surface soil. One area each for BaP and dioxins exceed the

high concentration hot spot levels. The dioxin hot spot location corresponds to an area identified as an ecological hot spot.

4.1.3 East Parcel

Except for two areas where COCs were detected above hot spot levels (one for PCBs and one for antimony, copper, lead, and zinc), ecological risks on the East Parcel are acceptable.

Except for the area along the BNSF railroad embankment where an ecological hot spot was identified, baseline human health risk is acceptable on the East Parcel for short-term or passive uses (e.g., construction, transient visitors, animal watching). For more active uses such as picnicking or athletics, baseline risks are unacceptable primarily as a result of BaP in surface soil (0 to 3 feet in depth). Arsenic is also a contributor to site risk, but it exceeds default background concentrations only at the BNSF embankment area hot spot.

4.2 Existing Conditions

Most of the Facility is flat with relatively good access. The primary exceptions are the riverbank and the embankment along the BNSF railroad. The riverbank is relatively steep and much of the bank is covered with riprap. A narrow strip of the Facility property runs along the base of the BNSF embankment and is bordered by the cove beach on one side and the steep embankment on the other.

Except for some remnant concrete foundations and limited paved areas, the Facility is vacant and reverting to natural conditions. The summary of vegetation communities in Appendix A shows that approximately 40 percent of the Facility is covered with hardwood forest that is targeted by the City and Metro for restoration. The remainder of the Facility is primarily scrub/shrub or meadow plant communities. The east end of the Central Parcel contains an area of non-native, ornamental landscape plants.

4.3 Site Use

Based on multiple factors such as property ownership, zoning, and government plans, the property is targeted for green space, ecological restoration, and park uses consistent with green spaces. Although some planning documents included consideration of more active recreational uses (e.g., picnicking), the property owner (Metro) understands that active recreational uses may not be suitable for the Facility and that deed restrictions could be required to limit site uses. The most specific discussion of future site use includes restoration of natural areas (creating ecological habitat), pathways, and passive recreational uses such as viewing of scenery and bird watching.

4.4 Coordination with Other Portland Harbor Activities

This FS addresses cleanup of the upland Facility at Willamette Cove. Other cleanup activities associated with the Portland Harbor cleanup include source control, in-water cleanup, and habitat restoration. These are briefly discussed below as they relate to potential upland cleanup options.

Source Control. The source control evaluation (summarized in Section 2.9) identified approximately 16 percent of the Facility riverbank needing source control. A source control remedy has not been identified because source control will likely be incorporated into the in-water remedy for Willamette Cove and the Portland Harbor FS is not yet complete (see further discussion below). Evaluation of upland remedial options will include consideration of potential source control actions.

In-Water Cleanup. The Portland Harbor FS is evaluating potential remedial alternatives for in-water cleanup. Potential remedies include dredging, various types of caps, *in situ* treatment, and several approaches to natural recovery. As discussed above, the in-water remedy will include source control actions on the riverbank. These potential in-water remedies will be factored into the evaluation of upland remedial actions.

Habitat Restoration. Restoration of the habitat along the Willamette Cove riverbank is likely. A riverbank restoration plan would likely include elements such as removal of riprap, removal of remnant pilings and other debris, flattening of the riverbank slope, removal of invasive species, and restoration of native vegetation. All or a portion of seven of the ten high concentration hot spot areas at the Facility are on or near the riverbank and would likely be within areas targeted for restoration.

5.0 Remedial Action Objectives and Evaluation Criteria

RAOs are medium-specific goals for protecting human health and the environment and provide the framework for developing and evaluating remedial action alternatives. RAOs were developed to address pathways that pose the potential for unacceptable risk and to remediate hot spots to the extent feasible. RAOs for the Facility are presented below.

5.1 Remedial Action Objectives

The following RAOs have been identified for the Facility.

5.1.1 Ecological

Table 1 lists the ecological COCs together with the concentrations corresponding to adverse impact to individuals and high concentration hot spots. Ecological receptors include plants, invertebrates, birds, and mammals. The following lists the specific RAOs for ecological receptors.

- Prevent exposure of ecological receptors to the hot spot areas (see Figure 8).
- In the Central Parcel, prevent or reduce exposure of ecological receptors to COCs in surface soil in the potential cleanup areas (see Figure 8).

5.1.2 Human Health

Table 2 lists the human health COCs together with the concentrations corresponding to adverse impact to receptors and high concentration hot spots. The following lists the specific RAOs for human receptors.

- Prevent active recreational exposure to surface soil on the West Parcel.
- Prevent exposure of active/passive recreational users and construction workers to surface soil on the Central Parcel.
- On the East Parcel:
 - Prevent active recreational exposure to surface soil in the potential cleanup areas (see Figure 8).
 - Prevent passive recreational exposure to the potential cleanup area on the BNSF railroad embankment (see Figure 8).
- Remove or treat hot spots to the extent practicable as defined by DEQ rules.

5.2 Evaluation Criteria

The evaluation of potentially feasible alternatives was based on the following criteria (OAR 340-122-085(4)).

5.2.1 Protectiveness

Protectiveness is a threshold requirement; only alternatives that meet the protectiveness requirements were evaluated (OAR 340-122-040). The protectiveness standards are:

- Ability of remedial action to protect present and future public health, safety, and welfare;
- Ability of remedial action to achieve acceptable risk levels specified in OAR 340-122-115;
- Ability of remedial action to prevent or minimize future releases and migration of hazardous substances in the environment; and
- Requirements for long-term monitoring, operation, maintenance, and review.

5.2.2 Balancing Factors

Balancing Factors include the following (OAR 340-122-090(3)):

- Effectiveness: Ability and timeframe of remedial action to achieve protection through eliminating or managing risk;

- Long-Term Reliability: Reliability of remedial action to eliminate or manage risk and associated uncertainties;
- Implementability: Ease or difficulty of implementing a remedial action considering technical, mechanical, and regulatory requirements; this will include evaluation of compatibility of the remedy with potential future source control actions, in-water remedies, and habitat restoration;
- Implementation Risk: Potential impacts to workers, the community, and the environment during implementation; and
- Reasonableness of Costs: Considers capital costs, operations and maintenance, and periodic review, and includes a net present-value evaluation of the remedial action.

5.2.3 Treatment or Removal of Hot Spots

Hot spots are evaluated based on the feasibility of treatment/removal of the hot spot using the above balancing factors with a higher threshold for cost reasonableness (OAR 340-122-085(5,6,7), -090(4)). The higher threshold is applied only as long as the hot spot exists.

6.0 Remedial Action Area and Extent

The extents of soil impacted by COCs at concentrations that exceed the respective PRGs and hot spot levels are shown on Figure 8 and described in Section 4.1. The following summarizes the areas and volumes of impacted soil used in the FS.

The spatial characteristics of the remedial action area are summarized as follows:

- West Parcel hot spot (one area):
 - Area: 2,500 square feet (sf)
 - Thickness: 3 feet
 - Volume: 280 cubic yards (cy)
 - Mass: 500 tons (assuming 1.7 tons per cy)
- Central Parcel hot spots (eight areas):
 - Area: 90,000 sf
 - Thickness: 3 feet
 - Volume: 10,000 cy
 - Mass: 17,000 tons (assuming 1.7 tons per cy)
- East Parcel hot spots (two areas):

- Area: 18,000 sf
- Thickness: 3 feet
- Volume: 2,000 cy
- Mass: 3,400 tons (assuming 1.7 tons per cy)
- West Parcel human health potential cleanup area
 - Area: 211,000 sf
 - Thickness: 3 feet
 - Volume: 23,000 cy
 - Mass: 40,000 tons (assuming 1.7 tons per cy)
- Central Parcel human health potential cleanup area:
 - Area: 385,000 sf
 - Thickness: 3 feet
 - Volume: 43,000 cy
 - Mass: 73,000 tons (assuming 1.7 tons per cy)
- Central Parcel ecological potential cleanup areas (two areas):
 - Area: 287,000 sf
 - Thickness: 3 feet
 - Volume: 32,000 cy
 - Mass: 54,000 tons (assuming 1.7 tons per cy)
- East Parcel human health potential cleanup area:
 - Area: 235,000 sf
 - Thickness: 3 feet
 - Volume: 26,000 cy
 - Mass: 44,000 tons (assuming 1.7 tons per cy)

7.0 Remedial Action Alternatives and Preliminary Screening

Initially, technologies associated with a list of general response actions were screened for applicability based on site and soil conditions and contaminant type. General response actions are broad categories of

remedial measures that address the RAOs. Technologies and corresponding response actions may be stand-alone remedial action alternatives or a component of a comprehensive alternative. The list of general response actions includes:

- No Action;
- Institutional/Engineering Controls;
- Removal;
- Containment;
- *In Situ* Biological Treatment;
- *In Situ* Physical/Chemical/Thermal Treatment;
- *Ex Situ* Biological Treatment; and
- *Ex Situ* Physical/Chemical/Thermal Treatment.

This section describes the development of the remedial action alternatives to be evaluated. The alternative development process includes identifying general response actions and corresponding technologies, screening technologies to eliminate technologies that are clearly not feasible, and assembling remaining technologies into a list of Site-specific cleanup action alternatives. This evaluation addresses the cleanup of impacted shallow soil because it is the only medium with identified unacceptable baseline risk.

7.1 Technology Screening

Table 3 provides a screening of the general response actions together with representative remedial action technologies for soil. Based on site use and type and extent of contaminants, these remedial action technologies were screened to identify a list of technologies to include in a more detailed evaluation of potential remedial action alternatives. The results of the screening are shown in Table 3, with the shaded technologies eliminated from further consideration. Comments on the table explain the rationale for eliminating technologies from further consideration. Technologies remaining for further evaluation after the initial screening are listed below.

General Response Action	Technology
No Action	No Action
Institutional Controls	Deed Restrictions/Soil Management Plan Monitoring
Engineering Controls	Access Restrictions
Containment	Capping
Removal and Disposal	Excavation Off-Site Disposal On-Site Disposal

<i>In Situ</i> Treatment	Immobilization
<i>Ex Situ</i> Physical Treatment	Solidification/Stabilization Separation

7.2 Development of Cleanup Action Alternatives

Supporting or Supplemental Technologies. Several of the technologies retained for evaluation are only suitable for use in conjunction with other technologies and would not be considered as standalone alternatives. Several of these technologies are applicable only if used in conjunction with other technologies and have been retained as Supporting Technologies, and several of the technologies may only be applicable if they are deemed appropriate during implementation of the potential cleanup alternatives as Supplemental Technologies. The Supporting and Supplemental Technologies are listed below.

Supporting Technologies	Supplemental Technologies
Soil Management Plan and Deed Restrictions	Solidification/Stabilization
Monitoring	Separation
Access Restrictions	
Off-Site Disposal	
On-Site Disposal	
Immobilization	

Cleanup Action Alternatives for Soil. The applicable primary, stand-alone cleanup technologies for soils include capping and excavation. These technologies are incorporated into cleanup action alternatives with the Supporting Technologies. The cleanup action alternatives for soil, therefore, include the following.

- No Action – This alternative is retained for comparison with other remedial action alternatives listed below.
- Cap – This alternative includes capping of the impacted soils using soil or pavement to prevent direct contact with or migration of impacted soil. Contaminated soils are not removed via capping and given the site contaminants, it is reasonable to assume that minimal degradation will occur. As such, implementation of engineering controls, such as signage to restrict access to areas of the site, and institutional controls, in the form of deed restrictions and a soil management plan (SMP), will be required. Routine, long-term cap maintenance inspections will be necessary in perpetuity. This alternative represents a conservative approach that results in no restrictions on the type of receptors that may use the site but requires long-term site management.
- Excavation and Off-Site Disposal – This alternative includes the complete removal of impacted soils from the site to a licensed landfill. Depending on the waste designation, the soil would be disposed of in a Subtitle D or C landfill. Alternatively, hazardous wastes could be treated to non-hazardous conditions (e.g., through stabilization) prior to disposal in a Subtitle D landfill. Following excavation, the site would be backfilled with clean soil or re-graded using existing site

soil. Continued monitoring would not be necessary. Separation technologies could be used to separate rock and debris from contaminated soil, reducing the amount of material disposed of in a landfill. This alternative represents a conservative approach that results in no site use restrictions.

- **Excavation and On-Site Disposal** – This alternative includes excavation of impacted soil and consolidating the soil in an on-site landfill. Selected areas could also be capped in place as part of the on-site landfill. Depending on the waste designation, the soil would be treated to non-hazardous conditions (e.g., through stabilization) prior to disposal. Alternatively, hazardous wastes, if any, could be disposed of off-site in a Subtitle C landfill with the remainder placed in the on-site landfill. As with the capping only alternative, implementation of secondary technologies associated with capping would also need to be implemented and long-term cap inspections would be necessary. Separation technologies could be used to separate rock and debris from contaminated soil, reducing the amount of material disposed beneath the cap. This alternative is primarily intended to allow comparison of off-site and on-site disposal.
- **Focused Excavation and Off-Site Disposal with Cap** – This alternative includes excavation of impacted soil with higher concentrations of COCs (hot spots at a minimum, but could include higher concentration non-hot-spot areas) for off-site disposal and capping remaining areas of impacted soil. As with the capping only alternative, implementation of secondary technologies associated with capping (engineering and institutional controls) would also need to be implemented and long-term cap inspections would be necessary. This alternative will facilitate evaluation of the feasibility of the removal of hot spots (by comparing this alternative to the cap alternative).
- **Focused Excavation and Off-Site Disposal with Alternate Cap and Access Restriction** – This alternative includes excavation of impacted soil from hot spot areas for off-site disposal. The remaining areas would be covered with a thin soil cap to address ecological risk through short-term reduction in direct contact risk and by enhancing natural recovery through mixing with native soils. If determined to be effective, the thin cap material could be enhanced with additives to immobilize contaminants and reduce bioavailability. Human health risks would be addressed through access restrictions (signage) and deed restrictions on site uses. Monitoring and long-term inspections would be necessary. This alternative combines conservative approaches for hot spots with cost-effective but protective approaches to address human and ecological risk.
- **Alternate Cap and Access Restriction** – This alternative includes the placement of a thin soil cap over areas of unacceptable risk to address ecological risk through short-term reduction in direct contact risk and by enhancing natural recovery through mixing with native soils. If determined to be effective, the thin cap material could be enhanced with additives to immobilize contaminants and reduce bioavailability. Human health risks would be addressed through access restrictions (signage) and deed restrictions on site uses. Monitoring and long-term inspections would be necessary. This alternative is a relatively low-cost alternative that is still protective to compare to the more costly and conservative approaches.

These alternatives are evaluated in detail in Section 8.

8.0 Detailed Analysis of Remedial Action Alternatives

This section describes and evaluates each of the remedial action alternatives identified in Section 7. Feasibility of the alternatives was evaluated using the criteria in Section 5.2.

Following the evaluation, a comparative analysis of each alternative relative to the other alternatives was completed (Section 9). The comparative analysis serves as the basis for selecting the recommended remedial action alternative (Section 10).

8.1 No Action

Description. According to OAR 340-122-085(2), a No Action alternative must be evaluated as a remedial action alternative. The No Action alternative assumes that no action is taken, no monitoring is performed, and no costs are incurred.

Protectiveness. The No Action alternative is not protective because it allows contaminants to be left in place at concentrations that exceed protective levels as determined from the baseline risk assessment.

Effectiveness. The No Action alternative does not effectively manage or eliminate risk.

Long-Term Reliability. The No Action alternative is not reliable because it does not manage or eliminate risk.

Implementability. The No Action alternative is the easiest of the alternatives to implement.

Implementation Risk. Since there are no construction or remediation activities associated with the No Action alternative, there is no risk to workers or the public during implementation of this alternative.

Reasonableness of Cost. There is no cost associated with the No Action alternative.

Treatment or Removal of Hot Spots. This alternative does not treat or remove the hot spots.

8.2 Cap

Description. For this alternative, the baseline risk would be managed with an engineered cap to prevent direct contact by both human and ecological receptors. Figure 9 shows the proposed cap area, and Figure 10 is a representative cap cross-section (inset A). In general, existing vegetation would be cleared to

the ground surface and recycled at a composting facility or reused on-site as mulch. Roots and other debris below the ground surface would remain. Two feet of clean, imported fill would be placed and the surface would be finished with native grasses, shrubs, and trees. A temporary irrigation system would be required for at least the first growing season. The cap would cover a total area of approximately 830,000 square feet for a total quantity of 62,000 cubic yards, or 100,000 tons of soil.

Along the riverbank, cap construction would need to be coordinated with source control actions and/or in-water remedial actions. Figure 11 shows a typical conceptual cross-section of the riverbank construction (inset D). In general, the riverbank would be excavated to reduce the slope to not greater than 3H:1V. The excavated soil would be placed upland, beneath the cap. The cap would extend down the riverbank, if needed, based on verification sampling of the excavated area. Work within 50 feet of the top of bank would be conducted as part of the source control, in-water remediation, and/or habitat restoration. This bank detail would be revised if further mitigation work is completed along the riverbank.

Dust control and use of personal protective equipment for construction workers are included in this alternative.

Operation and maintenance would include irrigation, cap inspection/repair, plant inspection and replacement, herbivory control, and invasive species control. A minimum of five years of active inspection and maintenance is expected. Long-term annual inspection would be required thereafter.

Institutional and engineering controls, including an SMP, signage, and designated pathways would be used indefinitely. A deed restriction identifying the presence of the cap and contamination would be required.

Capped areas could be developed for passive or active recreational use as discussed in planning documents. Other uses would also be possible provided that those uses are compatible with the presence of the cap and the associated restrictions.

Protectiveness. The cap alternative is protective of human and ecological receptors by preventing direct contact with soil containing COCs. Signs, deed restrictions, and the SMP would assure this protectiveness in the long term.

Effectiveness. Capping is a very effective means to address risks associated with direct contact or dust. A soil cap is effective in this case because the COCs have relatively low solubility so are immobile. None of the COC mass would be removed from the site. Long term, there would be some mixing of cap and underlying soils resulting from activity of burrowing mammals. Except potentially in hot spot areas, the resulting mixing of the soils is not expected to result in surface soil concentrations that exceed PRGs. Because this is a publicly owned property, the engineering and institutional controls are expected to

adequately manage long-term risk. The alternative is estimated to require less than six months to complete and it would be protective immediately after implementation.

Long-Term Reliability. The long-term reliability of this alternative requires maintenance of the cap, engineering and institutional controls, and enforcement of the SMP. Because this is a publicly owned property, the engineering and institutional controls are expected to adequately manage long-term risk.

Implementability. This alternative uses standard construction services that are readily available. Access to the site is through residential neighborhoods and the project would require on the order of 8,300 truck trips through the neighborhood, assuming 15 cy per truck and two trips per load. The site has several stands of mature native species that are targets for restoration under local government plans. This alternative would remove these trees. An upland cap is generally compatible with any potential source control action, in-water remedy, or habitat restoration. A portion of the cap could be removed as part of actions that reduce the overall slope of the bank. Remediation of areas along the riverbank would be implemented together with in-water remedies and source control actions.

Implementation Risk. Implementation risks include potential impacts to the community, site workers, and the environment during implementation, summarized as follows.

- **Community** – An estimated 8,300 truck trips would be required through the adjacent residential communities. This brings noise and air pollution to this neighborhood. Motor vehicle accidents, including the potential for vehicle/pedestrian or vehicle/bicycle accidents, are a possibility.
- **Site Workers** – Risks to construction workers include physical hazards from heavy construction equipment and inhalation of dust. These risks are readily addressed with engineering controls (e.g., high visibility gear, dust suppression) and personal protective gear.
- **Environment** – Much of the Facility is covered with native plant communities, including mature stands of madrone and poplar. This alternative would remove these plant communities, and although native species would be replanted, it would be decades before these mature trees would be replaced. Equipment and trucks used for the work would be diesel powered, contributing greenhouse gases to the atmosphere. Assuming the soil borrow source is located within 10 miles of the site, the project would generate approximately 80,000 truck miles.

Reasonableness of Cost. Table 4 provides a detailed cost estimate for this alternative. Costs include direct/indirect capital costs (e.g., design, permitting, construction), annual operation/maintenance costs, and costs of periodic reviews. Costs are stated in terms of net present value (NPV), assuming that capital costs are incurred in year zero. Costs for this alternative are summarized as follows.

Capital	\$ 3,692,000
Long-Term (NPV)	\$ 228,000

Contingency	\$ 588,000
Total (NPV)	\$ 4,510,000

Treatment or Removal of Hot Spots. This alternative does not treat or remove hot spots.

8.3 Excavation and Off-Site Disposal

Description. For this alternative, soil in the hot spot and cleanup areas would be excavated to a depth of three feet and disposed of in an off-site landfill. It is assumed that the soil would not be a hazardous waste (would be verified during design/construction). If necessary, stabilization could be used as a supplemental technology to treat hazardous wastes to non-hazardous conditions prior to disposal in a Subtitle D landfill; otherwise, hazardous wastes would require disposal at a Subtitle C landfill. Confirmation sampling may be completed to verify removal of the soil above the PRGs or hot spot levels.

Figure 9 shows the proposed excavation area. In general, existing vegetation would be cleared to the ground surface and recycled at a composting facility or re-used on-site as mulch. Roots and other debris below the ground surface would be excavated with the soil. One foot of clean, imported topsoil would be placed and the surface would be finished with native grasses, shrubs, and trees. A temporary irrigation system would be required for at least the first growing season. The total area of the excavation would be approximately 830,000 square feet for a total quantity of 92,000 cubic yards, or 160,000 tons of soil. The foot of topsoil would cover a total area of approximately 830,000 square feet for a total quantity of 31,000 cubic yards, or 52,000 tons of soil.

Along the riverbank, the construction would need to be coordinated with source control actions and/or in-water remedial actions. Figure 11 shows a typical conceptual cross-section of the riverbank construction (inset E). In general, the riverbank would be excavated to reduce the slope to not greater than 3H:1V. Riprap would be excavated separately or the soil would be passed through a screen to separate rock from soil disposed of off-site. Work within 50 feet of the top of bank would be conducted as part of the source control, in-water remediation, and/or habitat restoration. This bank detail would be revised if further mitigation work is completed along the riverbank.

Dust control and use of personal protective equipment for construction workers are included in this alternative.

Operation and maintenance would include irrigation, plant inspection and replacement, herbivory control, and invasive species control. A minimum of five years of active inspection and maintenance is expected. Long-term annual inspection would be required thereafter.

There would be no institutional or engineering controls.

Site use would be unrestricted.

Protectiveness. Landfill disposal achieves protection by removing the contaminated soil to a managed facility. Except for irrigation and plant maintenance during the first few years, there are no long-term monitoring, operations, or maintenance requirements.

Effectiveness. This alternative is effective because the impacted soil is removed off-site to a controlled landfill. The alternative is estimated to require less than six months to complete and it would be protective immediately after implementation.

Long-Term Reliability. Disposing of the soil at a landfill will eliminate the human health and ecological risks from the soil by removing the contaminant source to a managed facility. This alternative otherwise has good long-term reliability because the landfill is a controlled disposal facility that is required to conduct long-term maintenance and monitoring.

Implementability. This alternative uses standard construction services that are readily available. Access to the site is through residential neighborhoods and the project would require on the order of 16,000 truck trips through the neighborhood assuming 15 cy per truck and two trips per load. The site has several stands of mature native species that are targets for restoration under local government plans. This alternative would remove these trees. Excavation is generally compatible with any potential source control action, in-water remedy, or habitat restoration. Remediation of areas along the riverbank would be implemented together with in-water remedies and source control actions.

Implementation Risk. Implementation risks include potential impacts to the community, site workers, and the environment during implementation, summarized as follows.

- **Community** – An estimated 16,000 truck trips would be required through the adjacent residential communities. This brings noise and air pollution to this neighborhood. Motor vehicle accidents, including the potential for vehicle/pedestrian or vehicle/bicycle accidents, are a possibility.
- **Site Workers** – Risks to construction workers include physical hazards from heavy construction equipment and inhalation of dust. These risks are readily addressed with engineering controls (e.g., high visibility gear, dust suppression) and personal protective gear.
- **Environment** – Much of the Facility is covered with native plant communities, including mature stands of madrone and poplar. This alternative would remove these plant communities, and although native species would be replanted, it would be decades before these mature trees would be replaced. Equipment and trucks used for the work would be diesel powered, contributing greenhouse gases to the atmosphere. Assuming the landfill is located within 30 miles and the soil borrow source is located within 10 miles of the site, the project would generate approximately 410,000 truck miles.

Reasonableness of Cost. Table 5 provides a detailed cost estimate for this alternative. Costs include direct/indirect capital costs (e.g., design, permitting, construction), annual operation/maintenance costs, and costs of periodic reviews. Costs are stated in terms of NPV assuming that capital costs are incurred in year zero. Costs for this alternative are summarized as follows.

Capital	\$12,215,000
Long-Term (NPV)	\$ 167,000
Contingency	<u>\$ 1,858,000</u>
Total (NPV)	\$14,240,000

Treatment or Removal of Hot Spots. This alternative addresses the hot spots by complete removal to a controlled landfill.

8.4 Excavation and On-Site Disposal

Description. For this alternative, soil in the hot spot and cleanup areas would be excavated to a depth of three feet and disposed of in an on-site landfill. It is assumed that the soil would not be a hazardous waste (would be verified during design/construction). If necessary, stabilization could be used as a supplemental technology to treat hazardous wastes to non-hazardous conditions prior to disposal; otherwise hazardous wastes would require disposal at a Subtitle C landfill. Confirmation sampling may be completed to verify removal of the soil above the PRGs or hot spot levels.

Figure 12 shows the proposed excavation and landfill area (dimensions of approximately 250 by 875 feet). Figure 10 is a representative cap cross-section (inset B). In general, existing vegetation would be cleared to the ground surface and recycled at a composting facility or re-used on-site as mulch. Roots and other debris below the ground surface would be excavated with the soil. Outside the landfill area, one foot of clean, imported topsoil would be placed and the surface would be finished with native grasses, shrubs, and trees. The landfill area would be covered with two feet of soil and vegetated. A temporary irrigation system would be required for at least the first growing season. The total area of the excavation would be approximately 610,000 square feet (total area less the landfill footprint) for a total quantity of 68,000 cubic yards, or 120,000 tons of soil. One foot of topsoil would cover a total area of approximately 610,000 square feet for a total quantity of 23,000 cubic yards, or 38,000 tons of soil. The two-foot landfill cap would cover a total area of approximately 220,000 square feet for a total quantity of 16,000 cubic yards, or 28,000 tons of soil.

Along the riverbank, the construction would need to be coordinated with source control actions and/or in-water remedial actions. Figure 11 shows a typical conceptual cross-section of the riverbank construction (inset E). In general, the riverbank would be excavated to reduce the slope to not greater than 3H:1V. Riprap would be excavated separately or the soil would be passed through a screen to separate rock from

soil disposed of on site. Work within 50 feet of the top of bank would be conducted as part of the source control, in-water remediation, and/or habitat restoration. This bank detail would be revised if further mitigation work is completed along the riverbank.

Dust control and use of personal protective equipment for construction workers are included in this alternative.

Operation and maintenance would include irrigation, cap inspection/repair, plant inspection and replacement, herbivory control, and invasive species control. A minimum of five years of active inspection and maintenance is expected. Long-term annual inspection would be required thereafter.

For the landfill area, institutional and engineering controls including an SMP, signage, and designated pathways would be used indefinitely. A deed restriction identifying the presence of the cap and contamination would be required.

The capped area could be developed for passive or active recreational use as discussed in planning documents. Other uses would also be possible provided that those uses are compatible with the presence of the cap and the associated restrictions. Outside the capped area, site use would be unrestricted.

Protectiveness. On-site disposal achieves protection by removing the contaminated soil to a consolidated area that can be capped and maintained efficiently. In the capped area, signs, deed restrictions, and the SMP would assure this protectiveness in the long term. Outside the capped area, except for irrigation and plant maintenance during the first few years, there are no long-term monitoring, operations, or maintenance requirements.

Effectiveness. For much of the site, this alternative is effective because the impacted soil is removed to a controlled, on-site landfill. Capping of the landfill area is a very effective means to address risks associated with direct contact or dust. A soil cap is effective in this case because the COCs have relatively low solubility so are immobile. None of the COC mass would be removed from the site. Long term, there would be some mixing of cap and underlying soils resulting from activity of burrowing mammals. The resulting mixing of the soils is not expected to result in surface soil concentrations that exceed PRGs. Because this is a publicly owned property, the engineering and institutional controls are expected to adequately manage long-term risk. The alternative is estimated to require less than six months to complete and it would be protective immediately after implementation.

Long-Term Reliability. The long-term reliability of this alternative requires maintenance of the cap, engineering and institutional controls, and enforcement of the SMP. Because this is a publicly owned property, the engineering and institutional controls are expected to adequately manage long-term risk.

Implementability. This alternative uses standard construction services that are readily available. Access to the site is through residential neighborhoods and the project would require on the order of 5,000 truck trips through the neighborhood assuming 15 cy per truck and two trips per load. The site has several stands of mature native species that are targets for restoration under local government plans. This alternative would remove these trees. Excavation is generally compatible with any potential source control action, in-water remedy, or habitat restoration. Remediation of areas along the riverbank would be implemented together with in-water remedies and source control actions.

Implementation Risk. Implementation risks include potential impacts to the community, site workers, and the environment during implementation, summarized as follows.

- **Community** – An estimated 5,000 truck trips would be required through the adjacent residential communities. This brings noise and air pollution to this neighborhood. Motor vehicle accidents, including the potential for vehicle/pedestrian or vehicle/bicycle accidents, are a possibility.
- **Site Workers** – Risks to construction workers include physical hazards from heavy construction equipment and inhalation of dust. These risks are readily addressed with engineering controls (e.g., high visibility gear, dust suppression) and personal protective gear.
- **Environment** – Much of the Facility is covered with native plant communities including mature stands of madrone and poplar. This alternative would remove these plant communities, and although native species would be replanted, it would be decades before these mature trees would be replaced. Equipment and trucks used for the work would be diesel powered, contributing greenhouse gases to the atmosphere. Assuming the soil borrow source is located within 10 miles of the site, the project would generate approximately 50,000 truck miles.

Reasonableness of Cost. Table 6 provides a detailed cost estimate for this alternative. Costs include direct/indirect capital costs (e.g., design, permitting, construction), annual operation/maintenance costs, and costs of periodic reviews. Costs are stated in terms of NPV assuming that capital costs are incurred in year zero. Costs for this alternative are summarized as follows.

Capital	\$ 5,558,000
Long-Term (NPV)	\$ 274,000
Contingency	<u>\$ 875,000</u>
Total (NPV)	\$ 6,710,000

Treatment or Removal of Hot Spots. This alternative does not treat or remove the hot spots from the Facility. The hot spot soils are consolidated in one spot, reducing the overall area of the hot spots.

8.5 Focused Excavation and Off-Site Disposal with Cap

Description. For this alternative, soil in the hot spot areas would be excavated to a depth of three feet and disposed of in an off-site landfill. It is assumed that the soil would not be a hazardous waste (would be verified during design/construction). If necessary, stabilization could be used as a supplemental technology to treat hazardous wastes to non-hazardous conditions prior to disposal in a Subtitle D landfill; otherwise hazardous wastes would require disposal at a Subtitle C landfill. Confirmation sampling may be completed to verify removal of the soil above the hot spot levels. The excavations would be backfilled with on-site materials. Remaining on-site baseline risk would be managed with an engineered cap to prevent direct contact by both human and ecological receptors. Figure 13 shows the hot spot removal areas and the proposed cap area, and Figure 10 is a representative cap cross-section (inset C). In general, existing vegetation would be cleared to the ground surface and recycled at a composting facility or reused on-site as mulch. Roots and other debris below the ground surface would remain. After removal of the hot spots and site grading, two feet of clean, imported fill would be placed and the surface would be finished with native grasses, shrubs, and trees. A temporary irrigation system would be required for at least the first growing season. The cap would cover a total area of approximately 830,000 square feet for a total quantity of 62,000 cubic yards, or 100,000 tons of soil. The total area of the hot spot excavation would be approximately 113,000 square feet for a total quantity of 13,000 cubic yards, or 21,000 tons of soil.

Along the riverbank, cap construction would need to be coordinated with source control actions and/or in-water remedial actions. Figure 11 shows a typical conceptual cross-section of the riverbank construction. In general, the riverbank would be excavated to reduce the slope to not greater than 3H:1V. The excavated soil would be placed upland, beneath the cap. The cap would extend down the riverbank, if needed based on verification sampling of the excavated area. Work within 50 feet of the top of bank would be conducted as part of the source control, in-water remediation, and/or habitat restoration. This bank detail would be revised if further mitigation work is completed along the riverbank.

Dust control and use of personal protective equipment for construction workers are included in this alternative.

Operation and maintenance would include irrigation, cap inspection/repair, plant inspection and replacement, herbivory control, and invasive species control. A minimum of five years of active inspection and maintenance is expected. Long-term annual inspection would be required thereafter.

Institutional and engineering controls, including an SMP, signage, and designated pathways would be used indefinitely. A deed restriction identifying the presence of the cap and contamination would be required.

Capped areas could be developed for passive or active recreational use as discussed in planning documents. Other uses would also be possible provided that those uses are compatible with the presence of the cap and the associated restrictions.

Protectiveness. This alternative is protective of human and ecological receptors by preventing direct contact with soil containing COCs through a combination of removal of higher relative concentration material and prevention of direct contact through caps and engineering controls. In addition, the higher relative concentration materials would be removed from the site to a controlled landfill. Signs, deed restrictions, and the SMP would assure this protectiveness in the long term.

Effectiveness. This alternative is effective because the hot spot soil is removed off-site to a controlled landfill and the cap addresses remaining risks associated with direct contact or dust. A soil cap is effective in this case because the COCs have relatively low solubility so are immobile. Long-term, there would be some mixing of cap and underlying soils resulting from activity of burrowing mammals. The resulting mixing of the soils is not expected to result in surface soil concentrations that exceed PRGs. Because this is a publicly owned property, the engineering and institutional controls are expected to adequately manage long-term risk. The alternative is estimated to require less than six months to complete and it would be protective immediately after implementation.

Long-Term Reliability. Disposal of the hot spot soil has good long-term reliability because the landfill is a controlled disposal facility that is required to conduct long-term maintenance and monitoring. The long-term reliability of this alternative requires maintenance of the cap, engineering and institutional controls, and enforcement of the SMP. Because this is a publicly owned property, the engineering and institutional controls are expected to adequately manage long-term risk.

Implementability. This alternative uses standard construction services that are readily available. Access to the site is through residential neighborhoods and the project would require on the order of 10,000 truck trips through the neighborhood assuming 15 cy per truck and two trips per load. The site has several stands of mature native species that are targets for restoration under local government plans. This alternative would remove these trees. An upland cap is generally compatible with any potential source control action, in-water remedy, or habitat restoration. A portion of the cap could be removed as part of actions that reduce the overall slope of the bank. Remediation of areas along the riverbank would be implemented together with in-water remedies and source control actions.

Implementation Risk. Implementation risks include potential impacts to the community, site workers, and the environment during implementation, summarized as follows.

- **Community** – An estimated 10,000 truck trips would be required through the adjacent residential communities. This brings noise and air pollution to this neighborhood. Motor vehicle accidents, including the potential for vehicle/pedestrian or vehicle/bicycle accidents, are a possibility.
- **Site Workers** – Risks to construction workers include physical hazards from heavy construction equipment and inhalation of dust. These risks are readily addressed with engineering controls (e.g., high visibility gear, dust suppression) and personal protective gear.

- Environment – Much of the Facility is covered with native plant communities including mature stands of madrone and poplar. This alternative would remove these plant communities, and although native species would be replanted, it would be decades before these mature trees would be replaced. Equipment and trucks used for the work would be diesel powered, contributing greenhouse gases to the atmosphere. Assuming the landfill is located within 30 miles and the soil borrow source is located within 10 miles of the site, the project would generate approximately 130,000 truck miles.

Reasonableness of Cost. Table 7 provides a detailed cost estimate for this alternative. Costs include direct/indirect capital costs (e.g., design, permitting, construction), annual operation/maintenance costs, and costs of periodic reviews. Costs are stated in terms of NPV assuming that capital costs are incurred in year zero. Costs for this alternative are summarized as follows.

Capital	\$ 5,101,000
Long-Term (NPV)	\$ 228,000
Contingency	<u>\$ 1,333,000</u>
Total (NPV)	\$ 6,662,000

Treatment or Removal of Hot Spots. This alternative addresses the hot spots by complete removal to a controlled landfill.

8.6 Focused Excavation and Off-Site Disposal with Alternate Cap and Access Restriction

Description. This alternative would consist of hot spot excavation for off-site disposal, placement of a thin layer soil cap, and restricting site access and use.

Soil in the hot spot areas would be excavated to a depth of three feet and disposed of in an off-site landfill. It is assumed that the soil would not be a hazardous waste (would be verified during design/construction). If necessary, stabilization could be used as a supplemental technology to treat hazardous wastes to non-hazardous conditions prior to disposal in a Subtitle D landfill; otherwise hazardous wastes would require disposal at a Subtitle C landfill. Confirmation sampling may be completed to verify removal of the soil above the hot spot levels. The excavations would be backfilled with on-site materials.

Remaining ecological baseline risk would be managed with a six-inch soil cap covering the ecological cleanup areas in the Central Parcel. The thin-layer cap reduces ecological risk through two mechanisms. First, it would immediately prevent direct contact with soil for many species such as birds, plants, and invertebrates. Second, over time, activity by burrowing animals would mix the cap material into the surface soil, reducing overall concentrations of surface soil. During the design phase, immobilization additives could

be evaluated for use in the thin-layer cap. For example, the addition of activated carbon in the cap material could reduce the bioavailability of HPAHs in the western ecological cleanup area.

Remaining human health risk would be addressed through engineering and institutional controls including information signs providing background on the reclamation of the site and a deed notice restricting site uses to passive recreation only.

Figure 14 shows the hot spot removal areas and the proposed cap area, and Figure 10 is a representative cap cross-section (inset C). In general, existing vegetation would be completely cleared only in the hot spot areas. In the cap areas, shrubs/grasses would be closely mowed, but trees would remain. The thin-layer cap would be placed so as to not impinge on the drip line of larger trees. After placement of the thin-layer cap, the surface would be finished with native grasses and shrubs. A temporary irrigation system would be required for at least the first growing season. The cap would cover a total area of approximately 287,000 square feet for a total quantity of 5,300 cubic yards, or 9,000 tons of soil. The total area of the hot spot excavation would be approximately 113,000 square feet for a total quantity of 13,000 cubic yards, or 21,000 tons of soil.

Along the riverbank, construction would need to be coordinated with source control actions and/or in-water remedial actions. Figure 11 shows a typical conceptual cross-section of the riverbank construction (inset F). In general, the riverbank in the hot spot areas would be excavated to reduce the slope to not greater than 3H:1V. Outside the hot spot areas, the thin-layer cap would extend down the riverbank, if needed based on verification sampling. Work within 50 feet of the top of bank would be conducted as part of the source control, in-water remediation, and/or habitat restoration. This bank detail would be revised if further mitigation work is completed along the riverbank.

Dust control and use of personal protective equipment for construction workers are included in this alternative.

Operation and maintenance would include irrigation, plant inspection and replacement, herbivory control, and invasive species control. Five years of active inspection and maintenance is expected.

Institutional and engineering controls including a SMP, signage, and designated pathways would be used indefinitely. A deed restriction identifying the presence of the contamination and limitations on site use would be required.

Protectiveness. This alternative is protective of human and ecological receptors through a combination of removal of higher relative concentration material, prevention of direct contact through caps and engineering controls, and reduction of toxicity through immobilization and/or mixing of impacted soil with cap materials. Signs, deed restrictions, and the SMP would assure this protectiveness in the long term.

Effectiveness. This alternative is effective because the hot spot soil is removed off-site to a controlled landfill and the cap addresses remaining risks associated with direct contact or dust. A soil cap is effective in this case because the COCs have relatively low solubility so are immobile. Long term, there would be mixing of cap and underlying soils resulting from activity of burrowing mammals. The resulting mixing of the soils is not expected to result in surface soil concentrations that exceed PRGs. Because this is a publicly owned property, the engineering and institutional controls are expected to adequately manage long-term risk. The alternative is estimated to require less than six months to complete and it would be protective immediately after implementation.

Long-Term Reliability. Disposal of the hot spot soil has good long-term reliability because the landfill is a controlled disposal facility that is required to conduct long-term maintenance and monitoring. The long-term reliability of this alternative requires engineering and institutional controls and enforcement of the SMP. Because this is a publicly owned property, the engineering and institutional controls are expected to adequately manage long-term risk. Because this alternative relies on natural processes to mix the soil and thin-layer cap material, there is not a need for reliance on long-term cap maintenance.

Implementability. This alternative uses standard construction services that are readily available. Access to the site is through residential neighborhoods and the project would require on the order of 2,400 truck trips through the neighborhood assuming 15 cy per truck and two trips per load. The site has several stands of mature native species that are targets for restoration under local government plans. This alternative maintains these trees and much of the natural habitat. An upland cap is generally compatible with any potential source control action, in-water remedy, or habitat restoration. A small portion of the cap could be removed as part of actions that reduce the overall slope of the bank. Remediation of areas along the riverbank would be implemented together with in-water remedies and source control actions.

Implementation Risk. Implementation risks include potential impacts to the community, site workers, and the environment during implementation, summarized as follows.

- **Community** – An estimated 2,400 truck trips would be required through the adjacent residential communities. This brings noise and air pollution to this neighborhood. Motor vehicle accidents, including the potential for vehicle/pedestrian or vehicle/bicycle accidents, are a possibility.
- **Site Workers** – Risks to construction workers include physical hazards from heavy construction equipment and inhalation of dust. These risks are readily addressed with engineering controls (e.g., high visibility gear, dust suppression) and personal protective gear.
- **Environment** – This alternative would carry little risk to native plant communities. Equipment and trucks used for the work would be diesel powered, contributing greenhouse gases to the atmosphere. Assuming the landfill is located within 30 miles and the soil borrow source is located within 10 miles of the site, the project would generate approximately 59,000 truck miles.

Reasonableness of Cost. Table 8 provides a detailed cost estimate for this alternative. Costs include direct/indirect capital costs (e.g., design, permitting, construction), annual operation/maintenance costs, and costs of periodic reviews. Costs are stated in terms of NPV assuming that capital costs are incurred in year zero. Costs for this alternative are summarized as follows.

Capital	\$ 2,435,000
Long-Term (NPV)	\$ 51,000
Contingency	<u>\$ 622,000</u>
Total (NPV)	\$ 3,108,000

Treatment or Removal of Hot Spots. This alternative addresses the hot spots by complete removal to a controlled landfill.

8.7 Alternate Cap and Access Restriction

Description. This alternative would consist of placement of a thin-layer soil cap and restricting site access and use.

Ecological baseline risk would be managed with a 12-inch soil cap over hot spot areas within the ecological cleanup areas (Central Parcel) and a 6-inch soil cap covering the remaining ecological cleanup areas in the Central Parcel. The thin-layer cap reduces ecological risk through two mechanisms. First, it would immediately prevent direct contact with soil for many species such as birds, plants, and invertebrates. Second, over time, activity by burrowing animals would mix the cap material into the surface soil, reducing overall concentrations of surface soil. During the design phase, immobilization additives could be evaluated for use in the thin-layer cap. For example, the addition of activated carbon in the cap material could reduce the bioavailability of HPAHs in the western ecological cleanup area.

Human health risk would be addressed through engineering and institutional controls including information signs providing background on the reclamation of the site and a deed notice restricting site uses to passive recreation only.

Figure 15 shows the proposed cap area, and Figure 10 is a representative cap cross-section (inset C). In general, existing vegetation would be completely cleared only in the hot spot areas. In the cap areas, shrubs/grasses would be closely mowed, but trees would remain. The thin-layer cap would be placed so as to not impinge on the drip line of larger trees. After placement of the thin-layer cap, the surface would be finished with native grasses and shrubs. A temporary irrigation system would be required for at least the first growing season. The 12-inch cap would cover a total area of approximately 87,000 square feet and the 6-inch cap would cover a total area of approximately 200,000 square feet for a total quantity of 6,900 cubic yards, or 12,000 tons of soil.

Along the riverbank, construction would need to be coordinated with source control actions and/or in-water remedial actions. Figure 11 shows a typical conceptual cross-section of the riverbank construction (inset G). In general, the thin-layer cap would extend down the riverbank as needed. Work within 50 feet of the top of bank would be conducted as part of the source control, in-water remediation, and/or habitat restoration. This bank detail would be revised if further mitigation work is completed along the riverbank.

Dust control and use of personal protective equipment for construction workers are included in this alternative.

Operation and maintenance would include irrigation, plant inspection and replacement, herbivory control, and invasive species control. Five years of active inspection and maintenance is expected.

Institutional and engineering controls including a SMP, signage, and designated pathways would be used indefinitely. A deed restriction identifying the presence of the contamination and limitations on site use would be required.

Protectiveness. This alternative is protective of human and ecological receptors through a combination of prevention of direct contact through caps and engineering controls, and reduction of toxicity through immobilization and/or mixing of impacted soil with cap materials. Signs, deed restrictions, and the SMP would assure this protectiveness in the long term.

Effectiveness. A soil cap is effective in this case because the COCs have relatively low solubility so are immobile. None of the COC mass would be removed from the site. Long term, there would be mixing of cap and underlying soils resulting from activity of burrowing mammals. Except potentially in the hot spot areas, the resulting mixing of the soils is not expected to result in surface soil concentrations that exceed PRGs. Because this is a publicly owned property, the engineering and institutional controls are expected to adequately manage long-term risk. The alternative is estimated to require less than six months to complete and it would be protective immediately after implementation.

Long-Term Reliability. The long-term reliability of this alternative requires engineering and institutional controls and enforcement of the SMP. Because this is a publicly owned property, the engineering and institutional controls are expected to adequately manage long-term risk. Because this alternative relies on natural processes to mix the soil and thin-layer cap material, there is not a need for reliance on long-term cap maintenance.

Implementability. This alternative uses standard construction services that are readily available. Access to the site is through residential neighborhoods and the project would require on the order of 920 truck trips through the neighborhood assuming 15 cy per truck and two trips per load. The site has several stands of

mature native species that are targets for restoration under local government plans. This alternative maintains these trees and much of the natural habitat. An upland cap is generally compatible with any potential source control action, in-water remedy, or habitat restoration. A small portion of the cap could be removed as part of actions that reduce the overall slope of the bank. Remediation of areas along the riverbank would be implemented together with in-water remedies and source control actions.

Implementation Risk. Implementation risks include potential impacts to the community, site workers, and the environment during implementation, summarized as follows.

- Community – An estimated 840 truck trips would be required through the adjacent residential communities. This brings noise and air pollution to this neighborhood. Motor vehicle accidents, including the potential for vehicle/pedestrian or vehicle/bicycle accidents, are a possibility.
- Site Workers – Risks to construction workers include physical hazards from heavy construction equipment and inhalation of dust. These risks are readily addressed with engineering controls (e.g., high visibility gear, dust suppression) and personal protective gear.
- Environment – This alternative would carry little risk to native plant communities. Equipment and trucks used for the work would be diesel powered, contributing greenhouse gases to the atmosphere. Assuming the soil borrow source is located within 10 miles of the site, the project would generate approximately 9,200 truck miles.

Reasonableness of Cost. Table 9 provides a detailed cost estimate for this alternative. Costs include direct/indirect capital costs (e.g., design, permitting, construction), annual operation/maintenance costs, and costs of periodic reviews. Costs are stated in terms of NPV assuming that capital costs are incurred in year zero. Costs for this alternative are summarized as follows.

Capital	\$ 1,130,000
Long-Term (NPV)	\$ 33,000
Contingency	<u>\$ 291,000</u>
Total (NPV)	\$ 1,454,000

Treatment or Removal of Hot Spots. This alternative does not treat or remove hot spots.

9.0 Comparative Evaluation of Remedial Action Alternatives

This section of the FS presents an evaluation of the remedial action alternatives relative to one another. The comparative analysis is summarized in Table 10. In the table, each alternative is compared to each of the other alternatives for each evaluation criterion. An alternative is ranked as favorable (+), equal (0), or unfavorable (-) in relation to every other alternative. The scores are summed at the right of the table for each alternative and the alternatives are ranked. The following discussion provides the rationale for the comparative evaluation presented in Table 10.

9.1 Protectiveness

This criterion is pass/fail. An alternative must be protective as defined by OAR 340-122-040 to be acceptable. With the exception of the No Action alternative, each of the remedial action alternatives is protective of human health and the environment. The alternatives were not scored based on this criterion, but protectiveness was considered when ranking the alternatives in the right-hand column.

9.2 Effectiveness

In general, off-site disposal was ranked more effective than capping or on-site disposal because of better control of the impacted soil. For capping alternatives, smaller cap areas and thicker cap areas were deemed to be more effective.

9.3 Long-Term Reliability

For long-term reliability, off-site controlled landfill disposal was deemed to be more reliable. For capping alternatives, hot spot removal was assumed more reliable, and for capping alternatives that did not include hot spot removal, smaller cap areas were assumed more reliable. Other things being equal, alternatives that required less long-term maintenance were assumed to be more reliable.

9.4 Implementability

The No Action alternative was considered the most easily implemented remedial action. The remaining alternatives use similar equipment techniques, are similarly compatible with other actions, but have greatly differing impacts on the neighborhood and plant communities. The ability to implement these alternatives is assumed to be directly related to acceptance by the local community and local planning agencies. Alternatives with fewer truck trips and less impact to native vegetation were assumed to be more implementable.

9.5 Implementation Risk

The No Action alternative carries no implementation risk. Alternatives with greater quantities of earthwork carry greater risk from dust, vehicle accidents, noise/pollution, destruction of habitat, and generation of greenhouse gases and therefore rank lower. Alternatives were generally ranked in order of truck trips/truck miles with higher-ranked alternatives having fewer trips/miles.

9.6 Reasonableness of Cost

The following summarizes the present-worth total cost estimates for each alternative listed from least to most costly.

- No Action (\$0);
- Alternate Cap and Access Restriction (\$1,454,000);
- Focused Excavation and Off-Site Disposal with Alternate Cap and Access Restriction (\$3,108,000);
- Cap (\$4,510,000);
- Focused Excavation and Off-Site Disposal with Cap (\$6,662,000);
- Excavation and On-Site Disposal (\$6,710,000); and
- Excavation and Off-Site Disposal (\$14,240,000).

9.7 Treatment or Removal of Hot Spots

As discussed in Section 5.2.3, hot spots are evaluated based on the feasibility of treatment/removal of the hot spot using the balancing factors with a higher threshold for cost reasonableness. To evaluate the feasibility of hot spot removal, there are two sets of two alternatives that are essentially the same but for removal of the hot spots:

- Cap versus Focused Excavation and Off-Site Disposal with Cap; and
- Focused Excavation and Off-Site Disposal with Alternate Cap and Access Restriction versus Alternate Cap and Access Restriction.

In the limiting case, “a higher threshold for cost reasonableness” would give zero weight to the cost factor. Re-scoring these alternatives in Table 10 without the cost factor, in both cases the alternative that includes the hot spot removal ranks substantially higher. In terms of absolute costs, the average additional cost for hot spot removal is approximately \$1.9 million. Considering these factors, the additional cost to remove the hot spot is proportionate to the benefits gained.

10.0 Recommendation

10.1 Recommended Remedial Action Alternative: Focused Excavation and Off-Site Disposal with Alternate Cap and Access Restriction

Based on the evaluation of remedial action alternatives in Section 9, the recommended remedial action alternative for the Facility is Focused Excavation and Off-Site Disposal with Alternate Cap and Access Restriction. This alternative is recommended for the following reasons.

- The alternative is protective of human health and the environment through a combination of removal of higher relative concentration material, prevention of direct contact through caps and engineering controls, and reduction of toxicity through immobilization and/or mixing of impacted soil with cap materials.
- The alternative overall ranks the highest when considering the balancing factors with equal weighting.
- The alternative was not ranked lower than third in any of the balancing factor categories.
- The alternative removes the hot spots to a controlled landfill.

10.2 Permit or Permit Exemption Requirements

The recommended alternative consists primarily of excavation and filling of greater than 50 cubic yards of soil. The work will include excavation and/or filling both above and below the line of ordinary high water. A grading permit (or permit exemption) from the City of Portland will be required to complete the upland work. An in-water work permit (addressing federal and state requirements for filling, water quality, etc.) will be required from the U.S. Army Corps of Engineers for the work below the line of ordinary high water. No other permits are anticipated to be required.

10.3 Residual Risk Assessment

10.3.1 Residual Risk Methodology

The residual risks were evaluated to assess the projected level of health and/or ecological risk that is anticipated if the recommended alternative is implemented. Assessment of residual risk is intended to assist risk managers in determining whether a remedial action plan will result in acceptable risk.

The residual risk evaluation was conducted using the same methods used in the baseline RHHRA and RERA (Formation, 2013 and 2014). Exposure point concentrations (EPCs) were revised to reflect the effect

of the recommended alternative on exposure and risk. Residual risk was evaluated for the West Parcel Exposure Unit (EU), the Central Parcel EU, and the East Parcel EU.¹

The areas of elevated PCDD/Fs in the Wharf Road EU would be completely removed as a result of the hot spot excavations included in the recommended alternative. As a result, exposures are assumed to be within acceptable ranges and no additional analysis was conducted to quantify residual risks in that area. However, the lack of PCDD/F data elsewhere at the Facility is a data gap that will be considered in evaluating residual risk following implementation of the recommended remedy. In addition, sampling for PCDD/F is underway in the other EUs and the data will be available in the first quarter 2014. Residual risks will be further evaluated at that time.

For both human health and ecological receptors, the residual risk analysis is based on data from discrete samples. Composites are excluded because the already low number of samples, further reduced by the excavation, often prevented calculation of 90UCL values that are specified in Oregon DEQ guidance for risk assessments. The post-remedy EPCs were calculated by removing data from locations within the hot spot excavation areas from the data set, without replacement. This essentially assumes that the concentrations in the excavation areas approximate the average concentration represented by the rest of the samples. For most metals, this approach results in a higher EPC than replacing the removed data with background values, and therefore is more conservative. For organics, no background values are available under Oregon rules, and there is no established method for replacement. As a result, the method is equivalent to replacing the removed data with an average concentration.

The analysis does not quantify the reduction in exposure resulting from the deed restrictions or thin-layer cap. As described below, the removal of soils from hot spot areas results in substantial reduction in COC concentrations, and associated health risk. The analysis shows that hot spot removal results in acceptable risk levels in most areas for most potential receptors. Remaining residual risks will be managed through deed/land-use restrictions (human health) and the thin-layer cap (ecological risk).

10.3.2 Results for Human Health

The residual risk analysis was conducted for the three receptor types described in the RRA:

- **Transient Trespasser:** This scenario represents current exposures to trespassers that may camp (illegally) at the site for relatively short periods of time during a two-year period. The scenario applies only to adults.
- **Construction Worker:** This scenario represents individuals that may have contact with soils while building structures or conducting earthwork associated with the potential recreational development

¹ Although the Inner Cove Beach EU and Central Beach EU were included in the RRA, they are not part of the Upland Facility and therefore not considered in the FS.

such as restrooms, walkways, and shelters. The scenario assumes relatively high contact with soils, but for time periods that are associated with short-term construction projects. The scenario applies only to adults.

- **Recreational Trespasser/Park User (Park User):** This scenario represents current recreational use such as accessing the site for jogging, hiking, observing nature, or other similar passive recreational activities. Although access for these activities is currently not legal, such use is regularly observed. Under baseline conditions, it was assumed that future use of the site could include active recreational use such as playgrounds. Active recreational use is not currently planned to be allowed. The baseline scenario conservatively assumes an individual may use the site, including active recreational uses, over a lifetime. Therefore, the exposure and risk calculations assume child and adult exposures.

Tables showing the post-remediation carcinogenic and non-carcinogenic risks are presented in Appendix D, and the results of the analysis are summarized below for each of the receptors.

10.3.2.1 Transient Trespasser

Residual risks for the Transient Trespasser are below the thresholds for acceptable risk for all of the COCs, in all three EUs. Specifically, toxicity quotients (TQs) do not exceed 1 for non-cancer risks, and total cancer risk does not exceed 1×10^{-5} for combined carcinogenic chemicals, or 1×10^{-6} for individual carcinogens.

10.3.2.2 Construction Worker

Residual risks for the Construction Worker are below the thresholds for acceptable risk for all of the COCs, in all three EUs.

10.3.2.3 Recreational Trespasser/Park User

For the Recreational Trespasser/Park User, non-cancer TQs do not exceed acceptable levels. Residual cancer risks marginally exceed acceptable risk levels in some areas, primarily due to residual levels of PAHs. Cancer risk results are summarized below for each of the EUs.

- West Parcel – Total cancer risk is 2×10^{-5} , with risk from BaP (9×10^{-6}) exceeding acceptable risk level for individual chemicals. Nearly all of the exposure resulting in unacceptable risk levels is due to soil ingestion during childhood.
- Central Parcel – Total cancer risk is 3×10^{-5} , with risk from BaP, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3)pyrene exceeding acceptable risk level for individual chemicals (ranging from 2×10^{-6} to 2×10^{-5} total risk). Risk from arsenic also exceeds the threshold for individual chemicals, but the maximum detected concentration was less

than twice the regional background concentration. Most of the exposure resulting in unacceptable risk levels is due to soil ingestion during childhood.

- East Parcel – Total cancer risk is below the acceptable threshold of 1×10^{-5} , but risk from BaP (5×10^{-6}) exceeds the acceptable risk level for individual chemicals. Risk from arsenic also exceeds the threshold for individual chemicals, but after removal of hot spot areas, the maximum detected concentration of arsenic would be below the regional background concentration. Most of the exposure resulting in unacceptable risk levels was due to soil ingestion during childhood.

Results show that risks are substantially reduced compared to baseline conditions at the site. However, residual levels of PAHs (and possibly arsenic in the Central Parcel) outside the excavated areas could result in relatively low, but unacceptable exposures if no other actions are taken. The proposed land-use restrictions (restricting site use to passive recreation only) will reduce potential contact with surface soils sufficiently that overall exposures will be within acceptable ranges after the active remediation and site restrictions are in place.

10.3.3 Results for Ecological Risk

The RRA includes exposure and risk analysis for the following receptors:

- Plants and invertebrates;
- Birds, represented by American robin; and
- Mammals, represented by short-tailed shrew and long-tailed weasel.

COCs for plants, invertebrates, American robin, and short-tailed shrew include metals and organic chemicals. Consistent with the RERA, the RRA risk analysis for the long-tailed weasel was restricted to organic compounds that have the potential to biomagnify (Aroclors, pesticides). The RERA also included evaluation of the red-tailed hawk, but no COCs were identified under baseline conditions, so the red-tailed hawk was not evaluated in the RRA. The post-remediation residual risk analysis for the FS was conducted for the COCs that were identified in the RERA. Tables showing the post-remediation TQs are presented in Appendix D, and the results of the analysis are summarized below for each of the receptors.

10.3.3.1 Plants and Invertebrates

- West Parcel – Residual risks for plants and invertebrates are below the thresholds for acceptable risk following hot spot excavation.
- Central Parcel – For plants and/or invertebrates following hot spot excavation, multiple samples would contain copper, lead, mercury, zinc, and/or HPAHs at TQs from 2 to 10.
- East Parcel – Overall, residual risks for plants and invertebrates are concluded to be acceptable following excavation. Except for nickel in one sample, concentrations of COCs following

excavation are below background or the TQs are less than one. Nickel was detected in one sample at 50 mg/kg versus the default background concentration of 47 mg/kg.

10.3.3.2 Birds – American Robin

- West Parcel – No COCs were identified for the West Parcel.
- Central Parcel – Copper, lead, and zinc were identified as COCs. Post-excavation LOAEL TQs are projected to be 1.4 for copper, 10 for lead, and 0.7 for zinc (all insectivorous diets).
- East Parcel – Copper, lead, zinc, and Aroclors (PCBs) were identified as COCs. Hot spot excavation will reduce LOAEL TQs for copper, zinc, and Aroclors to acceptable levels (1.0 or lower). Lead LOAEL TQs will remain above 1.0, but the maximum concentration remaining after excavation is lower than the default regional background concentration (79 mg/kg). Therefore, the residual risk is within acceptable ranges for all COCs.

10.3.3.3 Mammals – Short-Tailed Shrew

- West Parcel – No COCs were identified for the West Parcel.
- Central Parcel – Antimony, copper, lead, zinc, and HPAHs were identified as COCs. For antimony, post-excavation risks are projected to be within acceptable range (i.e., LOAEL-based TQ not greater than 1.0). Post remediation LOAEL-based TQs are projected to be 1.5 for copper, 2.5 for lead, 1.1 for zinc, and 1.6 for HPAHs.
- East Parcel – Antimony, copper, lead, zinc, and Aroclors were identified as COCs. Post-excavation risks are projected to be within acceptable range for all COCs (i.e., LOAEL-based TQ not greater than 1.0).

10.3.3.4 Mammals – Long-Tailed Weasel

The bioaccumulative COCs analyzed for the weasel included mercury, Aroclors, and various pesticides. Risk estimates for post-excavation conditions correspond to acceptable risk for all of the parcels and COCs. For Aroclors on the Central Parcel, 19 of 21 samples analyzed were non-detect. The two samples with detected concentrations were associated with sampling location SSH on the East Parcel and were collected on the Central-East Parcel boundary. The maximum concentration detected in these two samples was 0.21 mg/kg Aroclor 1260, corresponding to a LOAEL-TQ of 2.3. Based on the limited detections, the location of the detections, and the relatively low TQ for the detected concentration, risk from Aroclors on the Central Parcel is acceptable.

10.3.4 Residual Risk Conclusions

Following completion of the proposed hot spot excavations under the recommended alternative, remaining residual risks are summarized as follows.

- West Parcel
 - Human Health – Risks meet the acceptable risk levels except that for the Recreational Trespasser/Park User, total cancer risk is 2×10^{-5} , and risk from BaP is 9×10^{-6} .
 - Ecological – Risks meet the acceptable risk levels.
- Central Parcel
 - Human Health – Risks meet the acceptable risk levels except for the Recreational Trespasser/Park User. Under that scenario, total cancer risk is 3×10^{-5} , and risk from arsenic and several individual PAHs range from 2×10^{-6} to 2×10^{-5} .
 - Ecological – Risks meet the acceptable risk levels except as follows.
 - For plants and/or invertebrates, multiple samples contain copper, lead, mercury, zinc, and/or HPAHs at TQs up to 2 to 10.
 - For the American robin, copper and lead had TQs of 1.4 and 10, respectively.
 - For the short-tailed shrew, copper, lead, zinc, and HPAHs had TQs of 1.5, 2.5, 1.1, and 1.6, respectively.
- East Parcel
 - Human Health – Risks meet the acceptable risk levels except that for the Recreational Trespasser/Park User, risk from BaP is 5×10^{-6} .
 - Ecological – Risks meet the acceptable risk levels.

The hot spot excavation and removal would substantially reduce exposure and risks for both human and ecological receptors. In most cases, projected risks are below acceptable thresholds. For human health, the residual risks would be managed through deed/land-use restrictions. For ecological receptors, residual risk estimates exceed threshold values only in the Central Parcel, with TQs ranging from 2 to 10. The effects of the thin-layer cap over approximately six acres of the Central Parcel were not quantified. However, the reduction in exposure from the cap, combined with conservatism built into the exposure estimates, result in qualitative risk estimates that are equivalent to acceptable risk levels for non-T/E species. The thin-layer cap was proposed, in part, to avoid damage to existing ecological features at the site, particularly the mature native trees. More aggressive remediation approaches, such as a thicker, more highly engineered cap or more extensive excavation, could damage the trees, resulting in adverse ecological effects that are not likely to result from the thin-layer cap. This approach is consistent with DEQ

feasibility study rules and guidance that consider the balance between such factors as the effectiveness of an alternative and associated implementation risk.

11.0 References

- Alta Planning & Design, 2010. Willamette Cove Trail Alignment Refinement Report. January 12, 2010 (revised January 28, 2010).
- Ash Creek, 2011. 2010 Source Control Sampling Results, Willamette Cove Upland Facility, Portland, Oregon. May 6, 2011.
- Ash Creek, 2012. Surface Soil Sampling Results — Former Wharf Road Area, Willamette Cove Upland Facility, Portland, Oregon. October 17, 2012.
- Ash Creek, 2013. Source Control Evaluation, Willamette Cove Upland Facility. February 13, 2013.
- Ash Creek/Newfields, 2008. Addendum to Riverbank Soil Sampling, Willamette Cove Upland Facility. October 2008.
- BBL/Ash Creek/NF, 2006. Riverbank Soil Sampling Report, Willamette Cove Upland Facility. May 5, 2006.
- City of Portland, 1999. Willamette Cove Management Plan Draft, Bureau of Parks and Recreation. May 25, 1999.
- City of Portland, 2001. Parks 2020 Vision, Bureau of Parks and Recreation. July 2001.
- City of Portland, 2004. Bureau of Planning Zoning Map 2222.
<http://www.portlandoregon.gov/bps/index.cfm?c=35101&a=55474>. July 10, 2004.
- City of Portland, 2012. Significant Scenic Resources - CON-05.
<http://www.portlandoregon.gov/bps/article/400445>
- Hart Crowser, 2003. Remedial Investigation (Volume I), Willamette Cove, Portland, Oregon, ECSI No. 2066. Prepared for Port of Portland/Metro, Project No. 23998, Task No. 730. March 11, 2003.
- Formation, 2013. *Residual Human Health Risk Assessment, Willamette Cove Upland Facility, Prepared for Apex Companies on behalf of Port of Portland*. December 2013.
- Formation, 2014. *Ecological Risk Assessment, Residual Risk Assessment, Willamette Cove Upland Facility, Prepared for Apex Companies on behalf of Port of Portland*. January 2014.

Table 1
Preliminary Remediation Goals for Ecological Receptors
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

Chemical of Concern	Units	Plants (mg/kg)			Invertebrates (mg/kg)		Birds (mg/kg)		Mammals (mg/kg)		Background ⁴	Lowest Eco RBC > Background	Preliminary Remediation Goal	Eco Risk Hot Spot ⁷
		Plant Screening Levels ¹	Alternative Plant PRGs based on Soil pH ²	Plant Hot Spot	Invertebrate Screening Levels ¹	Invertebrate Hot Spot	Birds ³	Bird Hot Spot	Mammals ³	Mammal Hot Spot				
Antimony	mg/Kg dw	5 ^a		50	not a COC		not a COC		2.7	27	0.56	2.7 Mammal	2.7	27
Chromium	mg/Kg dw	1 ^b		10	0.4 ^a	4	not a COC		not a COC		76	none	76	none
Copper	mg/Kg dw	70 ^c	115-251 for pH >6; Geomean = 160 ^c	700 (1,600)	80 ^c	800	223	2,230	401	4010	34	70 Plant	70	700
Lead	mg/Kg dw	120 ^c	141-316 for pH>6. Geomean = 211 ^c	1,200 (2,110)	not a COC		33	330	122	1220	79	120 Plant	120	1200
Mercury	mg/Kg dw	0.3 ^b		3	not a COC		not a COC		not a COC		0.23	0.3 Plant	0.3	3
Nickel	mg/Kg dw	38 ^c	32-177 for pH>6. Geomean = 62 ^c	380 (620)	not a COC		not a COC		not a COC		47	none	47.3	none
Zinc	mg/Kg dw	160 ^c	173-185 for pH>6. Geomean = 178 ^c	1,600 (1,780)	120 ^c	1,200	673	6,730	201	2010	180	201 Mammal	201	1200
HPAH ⁵	mg/Kg dw	not a COC			18 ^c	180	not a COC		5.6	56	na	5.6 Mammal	5.6	56
Dibenzofuran	mg/Kg dw	not a COC			not a COC		not a COC		0.002 ^a	2.00E-02	na	0.002 Mammal	0.002	0.02
Diesel ⁶	mg/Kg dw	See note 5			See note 5		See note 5		See note 5		na	-- --	--	--
Dioxin/Furan	mg/Kg dw	not a COC			not a COC		1.00E-04	1.00E-03	3.10E-06	3.1E-05	na	3.10E-06 Mammal	3.10E-06	3.10E-05
PCBs	mg/Kg dw	40 ^b		400	not a COC		0.734	7.34	0.098	0.98	na	0.098 Mammal	9.80E-02	0.98
Phthalates ^a	mg/Kg dw	See note 5			See note 5		See note 5		See note 5		na	-- --	--	--

¹Screening levels cited by sources for screening only, not meant as action levels for risk management.

²Soil toxicity values for plants based on test in which soil pH was => 6.0

³Calculated from site-specific exposure scenario, based on LOAEL

⁴Upper Prediction Limit values for Portland Basin from Table 4 in Oregon DEQ. 2013. "Development of Oregon Background Metals Concentrations in Soil". March 2013.

⁵The hot spot concentration for HPAHs was based on the EcoSSL, which listed only the value for combined HPAHs. As a result, no hot spot concentrations could be calculated for individual PAHs. As a result, the HPAH hot spot concentration was applied to individual PAHs to be consistent with the Oregon rules that specify hot spot concentrations apply only to individual chemicals (DEQ 1998, 2001).

⁶Diesel and Phthalates were identified in Table 4 of DEQ comments on the Eco RRA (July 19, 2013), but the basis for inclusion as COCs was not explained, and quantitative basis for analysis is not possible. Therefore, no PRGs were calculated.

Toxicity Level Sources:

- a - ORNL Ecological PRGs
- b - ORNL-Plant Screening Level
- c - EPA EcoSSLs
- d - Oregon DEQ Level II SLV (screening level)

⁷Lowest Ecological Hot Spot that is greater than Background.

Table 2
Preliminary Remediation Goals for Human Receptors
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

Chemical Of Concern	Receptor Scenario	Units	RBC	Pathway	Back-ground ²	PRG	HotSpot ³
Antimony	Construction Worker	mg/Kg dw	41.3	NC, Derm	0.56	41.3	413
Antimony	Recreational Trespasser/Park User	mg/Kg dw	32.7	NC, Derm	0.56	32.7	327
Arsenic	Recreational Trespasser/Park User	mg/Kg dw	1 ^a	Cancer	8.8	8.8	100 ^a
Copper	Recreational Trespasser/Park User	mg/Kg dw	9506	NC, Ing	34	9506	95060
Lead	Construction Worker	mg/Kg dw	614	NC, Ing	79	614	6140
Lead	Recreational Trespasser/Park User	mg/Kg dw	950	NC, Ing	79	950	9500
Aroclors	Construction Worker	mg/Kg dw	2.75	Cancer	na	2.75	275
Aroclors	Recreational Trespasser/Park User	mg/Kg dw	0.26	Cancer	na	0.26	26
Dioxin/furan TEQ	Transient Trespasser	mg/Kg dw	2.08E-04	Cancer	na	2.08E-04	2.08E-02
2,3,7,8-TCDF	Transient Trespasser	mg/Kg dw	2.08E-03	Cancer	na	2.08E-03	2.08E-01
2,3,7,8-TCDD	Transient Trespasser	mg/Kg dw	2.08E-04	Cancer	na	2.08E-04	2.08E-02
1,2,3,7,8-PeCDF	Transient Trespasser	mg/Kg dw	6.93E-03	Cancer	na	6.93E-03	6.93E-01
2,3,4,7,8-PeCDF	Transient Trespasser	mg/Kg dw	6.93E-04	Cancer	na	6.93E-04	6.93E-02
1,2,3,7,8-PeCDD	Transient Trespasser	mg/Kg dw	2.08E-04	Cancer	na	2.08E-04	2.08E-02
1,2,3,4,7,8-HxCDF	Transient Trespasser	mg/Kg dw	2.08E-03	Cancer	na	2.08E-03	2.08E-01
1,2,3,6,7,8-HxCDF	Transient Trespasser	mg/Kg dw	2.08E-03	Cancer	na	2.08E-03	2.08E-01
2,3,4,6,7,8-HxCDF	Transient Trespasser	mg/Kg dw	2.08E-03	Cancer	na	2.08E-03	2.08E-01
1,2,3,7,8,9-HxCDF	Transient Trespasser	mg/Kg dw	na	Cancer	na	na	na
1,2,3,4,7,8-HxCDD	Transient Trespasser	mg/Kg dw	2.08E-03	Cancer	na	2.08E-03	2.08E-01
1,2,3,6,7,8-HxCDD	Transient Trespasser	mg/Kg dw	2.08E-03	Cancer	na	2.08E-03	2.08E-01
1,2,3,7,8,9-HxCDD	Transient Trespasser	mg/Kg dw	2.08E-03	Cancer	na	2.08E-03	2.08E-01
1,2,3,4,6,7,8-HpCDF	Transient Trespasser	mg/Kg dw	2.08E-02	Cancer	na	2.08E-02	2.08E+00
1,2,3,4,7,8,9-HpCDF	Transient Trespasser	mg/Kg dw	2.08E-02	Cancer	na	2.08E-02	2.08E+00
1,2,3,4,6,7,8-HpCDD	Transient Trespasser	mg/Kg dw	2.08E-02	Cancer	na	2.08E-02	2.08E+00
OCDF	Transient Trespasser	mg/Kg dw	6.93E-01	Cancer	na	6.93E-01	6.93E+01
OCDD	Transient Trespasser	mg/Kg dw	6.93E-01	Cancer	na	6.93E-01	6.93E+01
Dioxin/furan TEQ	Construction Worker	mg/Kg dw	1.15E-04	Cancer	na	1.15E-04	1.2E-02
2,3,7,8-TCDF	Construction Worker	mg/Kg dw	1.15E-03	Cancer	na	1.15E-03	1.2E-01
2,3,7,8-TCDD	Construction Worker	mg/Kg dw	1.15E-04	Cancer	na	1.15E-04	1.2E-02
1,2,3,7,8-PeCDF	Construction Worker	mg/Kg dw	3.85E-03	Cancer	na	3.85E-03	3.9E-01
2,3,4,7,8-PeCDF	Construction Worker	mg/Kg dw	3.85E-04	Cancer	na	3.85E-04	3.9E-02
1,2,3,7,8-PeCDD	Construction Worker	mg/Kg dw	1.15E-04	Cancer	na	1.15E-04	1.2E-02
1,2,3,4,7,8-HxCDF	Construction Worker	mg/Kg dw	1.15E-03	Cancer	na	1.15E-03	1.2E-01
1,2,3,6,7,8-HxCDF	Construction Worker	mg/Kg dw	1.15E-03	Cancer	na	1.15E-03	1.2E-01
2,3,4,6,7,8-HxCDF	Construction Worker	mg/Kg dw	1.15E-03	Cancer	na	1.15E-03	1.2E-01
1,2,3,7,8,9-HxCDF	Construction Worker	mg/Kg dw	na	Cancer	na	na	na
1,2,3,4,7,8-HxCDD	Construction Worker	mg/Kg dw	1.15E-03	Cancer	na	1.15E-03	1.2E-01
1,2,3,6,7,8-HxCDD	Construction Worker	mg/Kg dw	1.15E-03	Cancer	na	1.15E-03	1.2E-01
1,2,3,7,8,9-HxCDD	Construction Worker	mg/Kg dw	1.15E-03	Cancer	na	1.15E-03	1.2E-01
1,2,3,4,6,7,8-HpCDF	Construction Worker	mg/Kg dw	1.15E-02	Cancer	na	1.15E-02	1.2E+00
1,2,3,4,7,8,9-HpCDF	Construction Worker	mg/Kg dw	1.15E-02	Cancer	na	1.15E-02	1.2E+00
1,2,3,4,6,7,8-HpCDD	Construction Worker	mg/Kg dw	1.15E-02	Cancer	na	1.15E-02	1.2E+00
OCDF	Construction Worker	mg/Kg dw	3.85E-01	Cancer	na	3.85E-01	3.9E+01
OCDD	Construction Worker	mg/Kg dw	3.85E-01	Cancer	na	3.85E-01	3.9E+01
Dioxin/furan TEQ	Recreational Trespasser/Park User	mg/Kg dw	1.13E-05	Cancer	na	1.13E-05	1.1E-03
2,3,7,8-TCDF	Recreational Trespasser/Park User	mg/Kg dw	1.13E-04	Cancer	na	1.13E-04	1.1E-02
2,3,7,8-TCDD	Recreational Trespasser/Park User	mg/Kg dw	1.13E-05	Cancer	na	1.13E-05	1.1E-03
1,2,3,7,8-PeCDF	Recreational Trespasser/Park User	mg/Kg dw	3.75E-04	Cancer	na	3.75E-04	3.8E-02
2,3,4,7,8-PeCDF	Recreational Trespasser/Park User	mg/Kg dw	3.75E-05	Cancer	na	3.75E-05	3.8E-03
1,2,3,7,8-PeCDD	Recreational Trespasser/Park User	mg/Kg dw	1.13E-05	Cancer	na	1.13E-05	1.1E-03
1,2,3,4,7,8-HxCDF	Recreational Trespasser/Park User	mg/Kg dw	1.13E-04	Cancer	na	1.13E-04	1.1E-02
1,2,3,6,7,8-HxCDF	Recreational Trespasser/Park User	mg/Kg dw	1.13E-04	Cancer	na	1.13E-04	1.1E-02
2,3,4,6,7,8-HxCDF	Recreational Trespasser/Park User	mg/Kg dw	1.13E-04	Cancer	na	1.13E-04	1.1E-02
1,2,3,7,8,9-HxCDF	Recreational Trespasser/Park User	mg/Kg dw	na	Cancer	na	na	1.13E-02
1,2,3,4,7,8-HxCDD	Recreational Trespasser/Park User	mg/Kg dw	1.13E-04	Cancer	na	1.13E-04	1.1E-02
1,2,3,6,7,8-HxCDD	Recreational Trespasser/Park User	mg/Kg dw	1.13E-04	Cancer	na	1.13E-04	1.1E-02
1,2,3,7,8,9-HxCDD	Recreational Trespasser/Park User	mg/Kg dw	1.13E-04	Cancer	na	1.13E-04	1.1E-02
1,2,3,4,6,7,8-HpCDF	Recreational Trespasser/Park User	mg/Kg dw	1.13E-03	Cancer	na	1.13E-03	1.1E-01
1,2,3,4,7,8,9-HpCDF	Recreational Trespasser/Park User	mg/Kg dw	1.13E-03	Cancer	na	1.13E-03	1.1E-01
1,2,3,4,6,7,8-HpCDD	Recreational Trespasser/Park User	mg/Kg dw	1.13E-03	Cancer	na	1.13E-03	1.1E-01
OCDF	Recreational Trespasser/Park User	mg/Kg dw	3.75E-02	Cancer	na	3.75E-02	3.8E+00
OCDD	Recreational Trespasser/Park User	mg/Kg dw	3.75E-02	Cancer	na	3.75E-02	3.8E+00

Please refer to notes at end of table.

Table 2
Preliminary Remediation Goals for Human Receptors
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

Chemical Of Concern	Receptor Scenario	Units	RBC	Pathway	Back-ground ²	PRG	HotSpot ³
Total BaPEq	Transient Trespasser	mg/Kg dw	1.97	Cancer	na	1.97	197
Benzo(a)anthracene	Transient Trespasser	mg/Kg dw	19.7	Cancer	na	19.7	1970
Benzo(a)pyrene	Transient Trespasser	mg/Kg dw	1.97	Cancer	na	1.97	197
Benzo(b)fluoranthene	Transient Trespasser	mg/Kg dw	19.7	Cancer	na	19.7	1970
Dibenzo(a,h)anthracene	Transient Trespasser	mg/Kg dw	1.97	Cancer	na	1.97	197
Total BaPEq	Construction Worker	mg/Kg dw	0.75	Cancer	na	0.75	75
Benzo(a)anthracene	Construction Worker	mg/Kg dw	7.5	Cancer	na	7.5	750
Benzo(a)pyrene	Construction Worker	mg/Kg dw	0.75	Cancer	na	0.75	75
Benzo(b)fluoranthene	Construction Worker	mg/Kg dw	7.5	Cancer	na	7.5	750
Dibenzo(a,h)anthracene	Construction Worker	mg/Kg dw	0.75	Cancer	na	0.75	75
Total BaPEq	Recreational Trespasser/Park User	mg/Kg dw	0.0029	Cancer	na	0.0029	0.29
Benzo(a)anthracene	Recreational Trespasser/Park User	mg/Kg dw	0.029	Cancer	na	0.029	2.9
Benzo(a)pyrene	Recreational Trespasser/Park User	mg/Kg dw	0.0029	Cancer	na	0.0029	0.29
Benzo(b)fluoranthene	Recreational Trespasser/Park User	mg/Kg dw	0.029	Cancer	na	0.029	2.9
Dibenzo(a,h)anthracene	Recreational Trespasser/Park User	mg/Kg dw	0.0029	Cancer	na	0.0029	0.29

Notes:

NC, Derm = non-cancer endpoint, dermal exposure

NC, Ing = non-cancer endpoint, ingestion

Cancer, Ing = Cancer endpoint, ingestion

¹Calculated from Willamette Cove Upland Facility-specific exposure scenarios from the Residual Risk Assessment.

²Upper Prediction Limit values for Portland Basin from Table 3 in Oregon DEQ. 2013. "Development of Oregon Background Metals Concentrations in Soil". March 2013.

³For carcinogenic PAHs, the high concentration hot spot value is based on benzo(a)pyrene [BaP]. The concentrations of other individual cPAHs was converted using BaP toxicity equivalents, a - The PRG is set to the Urban Residential value from the DEQ Petroleum RBDMs (DEQ 2003, 2012).

Oregon DEQ. 2003, 2012. Risk-Based Decision Making (RBDM) for the Remediation of Petroleum-Contaminated Sites. Updated RBDM values (June 2012) are available at <http://www.deq.state.or.us/lq/pubs/docs/RBDMTable.pdf>.

Table 3
Initial Screening and Evaluation of Technologies for Soil
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

General Response Actions	Technology	Description	Screening Criteria			Screening Comments
			Effectiveness	Implementability	Cost	
NO ACTION	No Action	No Action	Not effective in achieving RAOs.	Easy to implement.	No capital or O&M costs incurred.	Does not meet threshold criteria. Required to be included for comparison purposes.
INSTITUTIONAL CONTROLS	Deed Restrictions/ Soil Management Plan	Can prevent disturbance of any required soil cap or other engineering controls, address notification of Site hazards, and ensure proper controls are implemented during future Site activities. Protocols will be established for handling and managing contaminated soils during future Site work to protect workers, public health, and the environment	Effective at regulating human direct contact, but is not effective at preventing erosion or ecological exposures, and does not address contaminant reduction. Soil management plan useful for addressing future interaction with impacted soils.	Deed restriction reasonably easy to complete. Soil management plan would need to be prepared and maintained in perpetuity.	Low costs associated with implementing soil management plan and deed restrictions.	Institutional controls are useful technologies to address risks during cleanup and to address residuals remaining after primary cleanup. Would be necessary for alternatives that maintain impacted soil on-site (such as capping). Generally only applicable to human receptors.
	Monitoring	Laboratory analysis of soil samples.	Effective for documenting Site conditions to evaluate migration and current Site risks. Does not address contaminant reduction.	Moderately easy to implement. Repeat sampling events may be necessary for tracking progress of active treatment technologies, which would require multiple mobilizations.	Low to moderate costs for monitoring.	Applicable to document Site conditions and effectiveness of any treatment. Must be used in conjunction with other technologies. Would include regular inspections of implemented technology (such as capping) and erosion control.
ENGINEERING CONTROLS	Access Restrictions	Use of fencing, signage, or other controls to limit access to impacted soils.	Effective at preventing human direct contact exposure to shallow impacted soil. Not effective at preventing erosion or ecological exposures.	Reasonably easy to implement for shallow soils. Would restrict use of property, but probably consistent with future site use.	Low costs associated with implementing controls.	Applicable especially in interim prior to park development. Because addresses only human receptors, must be used in conjunction with other technologies.
	Control of Building HVAC System	Use HVAC system to maintain positive pressure in buildings.	Not effective for inorganic or non-volatile contaminants (is used to prevent migration of volatile contaminants from soil into indoor air). Does not address migration to other media or contaminant reduction. Generally used in conjunction with other engineering controls.	Not relevant to the site - no HVAC systems. Could be implemented for potential future construction.	Low implementation costs and low to moderate operation costs if used for future construction.	Not relevant to the Site under current or expected future conditions (no buildings onsite). Not effective for non-volatile contamination.
	Vapor Barriers	Installation of low-permeability barriers beneath structures to prevent vapor intrusion. Alternatively, can place sealants on floor slabs or paved surfaces.	Not effective for inorganic or non-volatile contaminants (is used to prevent migration of volatile contaminants from soil into indoor air). Does not address migration to other media or contaminant reduction.	Easy to implement for new building construction. Products readily available for sealing these surfaces.	Low to moderate cost for vapor barriers in new construction.	Not relevant to the Site under current or expected future conditions (no buildings onsite). Not effective for non-volatile contamination.
	Sub-Slab Depressurization or Sub-Floor Venting	Installation of sub-slab venting systems or suction pits to create negative pressures beneath structures to prevent vapor migration to ambient air. Vapors are collected in the suction pit or venting pipes below the building and vented to the outside of the building, either passively or with fans.	Not effective for inorganic or non-volatile contaminants. Used to prevent migration of subsurface volatile contaminants from soil into ambient air. Does not address contaminant reduction.	Easy to implement for new building construction. Materials and construction methods are readily available. Generally most suitable for buildings with slab-on-grade floors.	Low to moderate cost for installation of sub-floor venting in new construction.	Not relevant to the Site under current or expected future conditions (no buildings onsite). Not effective for non-volatile contamination.
CONTAINMENT	Capping	Installation of an engineered cap (e.g., soil, asphalt, impermeable liner) over impacted soils.	Effective at preventing direct contact with contaminated soils. Does not address contaminant reduction but engineered cap can prevent erosion. Cap design can also be compatible with expected future site use.	Site is unimproved and installation of a cap would be reasonably easy. However, cap installation would eliminate existing habitat. Cap design would need to account for bank erosion potential. Cap would need to be maintained in perpetuity. Cap design could be incorporated into land use design for anticipated future use	Moderate to high construction cost for installation of cap. Low to moderate costs for ongoing maintenance of cap to maintain effectiveness.	Potentially applicable to the site to prevent direct contact and prevent bank erosion. Specific technology used would have to be compatible with future expected use (e.g., expansive asphalt concrete cap is not applicable, but a soil cap with strategically placed paved trails may be).
REMOVAL AND DISPOSAL	Excavation	Excavation of some or all of the contaminated soil for subsequent treatment and/or disposal. Focused excavation may include only higher concentrations or "hot spot" soil. Site restoration could include backfill with treated soil, imported soil, or re-grading surface soil.	Effective for removing source material from site or consolidating soil under an on-site cap. Addresses direct exposure pathways and migration by reducing or controlling on-site mass.	Implementation involves conventional construction equipment and methods. Integration into land use plan would be feasible. Depending on extent of excavation, could eliminate existing habitat.	Moderate to high costs due to required soil volumes.	Applicable to the site.
	Off-site Disposal	Off-site disposal of excavated soil at licensed disposal facility. Soils would require waste profiling and approval by the disposal facility.	Effective for containing contaminated soils and reducing risks associated with direct exposure.	Implementation involves transportation of contaminated soils on public roads. Non-soil wastes (rock and debris) may be separable to reduce disposal volume.	Moderate to high costs depending upon soil volumes and characterization.	Applicable to the site.
	On-Site Disposal	Consolidate excavated soil in an on-site, capped disposal area such as a berm along the rail line to reduce noise.	Effective by consolidating on-site soil in a controlled area to prevent exposure. Because the primary concern is direct contact, a soil cap would be effective.	Implementation involves conventional construction equipment and methods. Integration into land use plan would be feasible. Depending on extent of excavation, could eliminate existing habitat.	Moderate to costs depending upon soil volumes.	Applicable to the site.

Please refer to note at end of table.

Table 3
Initial Screening and Evaluation of Technologies for Soil
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

General Response Actions	Technology	Description	Screening Criteria			Screening Comments
			Effectiveness	Implementability	Cost	
/IN SITU/ PHYSICAL/ CHEMICAL/ THERMAL TREATMENT	Soil Vapor Extraction (SVE)	SVE involves extraction of vapors from the vadose zone using system of vertical wells or horizontal vents and vacuum pumps/blowers. Treatment of the discharge may be required.	Not effective for inorganic or non-volatile contamination.	Not applicable for treatment of inorganic or non-volatile contaminants. Would use well-established technologies and implementation is straightforward, but implementation would be ineffective.	SVE system would have moderate capital and O&M costs.	Not suitable for Site conditions (shallow soils) and target contamination (inorganics and non-volatiles).
	Electrokinetic Separation	Application of a low-intensity direct current through the soil between electrodes that are divided into a cathode array and an anode array. This mobilizes charged species, causing ions and water to move toward the electrodes.	Effective for removing inorganic ions and polar organics from saturated soil. Most effective in low-permeability soils (particularly clays). Not effective for vadose zone soil without supplemental saturation. Not effective for all contaminants.	Requires significant power supply and would require saturation of shallow soils over large area.	Very high implementation cost.	Not suitable to Site conditions (unsaturated soil). Would not address all contamination and would result in high expense with no benefit.
	Fracturing	Development of cracks in low-permeability or overconsolidated soils to create passageways that increase the effectiveness of other <i>in situ</i> processes and extraction technologies.	Effective in conjunction with other technologies (e.g., vapor extraction) in deep, fine-grained or consolidated soils. Not effective with shallow soil.	Specialized equipment and personnel needed to safely implement.	Moderate implementation cost.	Not suitable for Site conditions (shallow soil and inorganic contaminants).
	Chemical Oxidation	Chemically converts hazardous contaminants to less toxic compounds. Effective in destroying organic contaminants and oxidizing inorganic contaminants to less toxic/less mobile forms. Can include oxidant chemicals such as peroxides, permanganates, or ozone.	Can be highly effective at destruction of organic contaminants or oxidation of inorganics. Can be difficult to achieve full coverage (contact between oxidant and COIs), particularly in unsaturated soils. Not applicable to inorganics. Would be destructive to existing beneficial organics in soil.	Equipment and vendors are readily available. Delivery difficult in unsaturated soils.	High to Very High implementation cost.	Although Potentially applicable to organic contaminants, the benefit to inorganic contaminants is limited at best. High cost and significant material handling effort likely required. Given that metals and organics are mostly co-located, not applicable to site.
	Soil Flushing	Water (or water containing an additive to enhance contaminant solubility) is circulated through the soil to desorb contaminants, recovered, and treated. Implementation can involve injection followed by removal (such as via vacuum truck).	May be effective for soluble inorganics but would require groundwater extraction/treatment operation and ongoing saturation of vadose zone treatment area.	Difficult to maintain control of amended water. Inefficient process for unsaturated soils.	High implementation cost.	Not retained because less effective in shallow unsaturated zone. Would require significant infrastructure for water extraction and treatment. High associated cost.
	Solidification/Stabilization/ Vitrification/Immobilization	Contaminants are physically bound or enclosed within a stabilized mass (solidification and vitrification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization), or additives are uses to to reduce mobility or bioavailability of contaminants (immobilization). Could be directly applied/mixed with soil or applied as part of an active capping approach	Potentially suitable to reducing mobility of and accessibility to site contaminants. Difficult to ensure complete enclosure of soil with in-situ process. Reduction of bioavailability of organic contaminants could be effective with use of (for example) carbon addition to soil.	Difficult to obtain full stabilization in-situ in heterogeneous subsurface by injection. Vitrification would require significant power supply. Finished product would not be compatible with anticipated future site use. Incorporation of additives into cap materials relative simple.	High to very high implementation cost, except that incorporation of additives into cap material relatively inexpensive.	Immobilization to reduce bioavailability retained as potentially useful technology to combine with capping. Other process options not retained because less suitable to Site conditions and high cost.
	Thermally-Enhanced Removal	High-energy injection (steam/hot air, electrical resistance, electromagnetic, fiber optic, radio frequency) is used to increase the recovery rate of semi-volatile or non-volatile compounds to facilitate extraction (enhanced volatilization or decreased viscosity).	Most suitable to semi-volatile organic contaminants or viscous compounds that are not otherwise extractable with vapor extraction or fluid extraction technologies.	Generally used in conjunction with SVE system or other recovery system (i.e., groundwater extraction). Has high energy requirements. Not applicable for treatment of inorganic contaminants.	High implementation cost.	Not effective for inorganic contamination.
/IN SITU/ BIOLOGICAL TREATMENT	Bioventing	Bioventing involves inducing air or oxygen flow in the unsaturated zone to promote biodegradation of hydrocarbons and VOCs. Applications include injection of air or oxygen into subsurface, or extraction of air at rates lower than SVE.	Not effective with inorganic contaminants. Degradation of site-specific organic COCs expected to be very slow.	Not applicable for treatment of inorganic Site contaminants. Would use well-established technologies and implementation is straightforward, but implementation would be ineffective.	Low to moderate capital and O&M costs.	Not effective for inorganic contamination.

Please refer to note at end of table.

Table 3
Initial Screening and Evaluation of Technologies for Soil
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

General Response Actions	Technology	Description	Screening Criteria			Screening Comments
			Effectiveness	Implementability	Cost	
IN SITU BIOLOGICAL TREATMENT—CONTINUED	Enhanced Bioremediation (Bioaugmentation, Biostimulation)	Adding nutrients, electron acceptor, or other amendments to enhance bioremediation.	Most effective with organic contaminants, but can be used to change oxidative state of inorganics. Can be difficult to achieve full coverage (contact with COIs), particularly in unsaturated soils.	Would require saturation of treatment area, and would be inefficient for stabilization of target COIs.	Low to moderate costs depending on number of injection events required.	Not suitable for shallow unsaturated soil and would have marginal benefit (if any) to site contaminants. Any benefit would be slow to complete and would not be compatible with anticipated future site use in the meantime.
	Land Treatment	Combination of aeration (tilling) and amendments to enhance bioremediation in surface soils.	Effective for organic contaminants in shallow soil that can be degraded aerobically. Not effective for deeper contamination or inorganics.	Common agricultural equipment can be used to process shallow soil. Not applicable for treatment of inorganic contaminants.	Low to moderate implementation cost.	Not retained because incompatible with Site contamination and depth to contaminants. Similar application with potentially viable additives (i.e., oxidants) covered under chemical oxidation alternative.
	Monitored Natural Attenuation	Using natural processes to reduce contaminant concentrations to acceptable levels. Process is closely monitored to verify exposures are acceptable prior to concentrations reaching acceptable levels.	Most effective with organic contaminants, but natural processes can change oxidative state of inorganics. Likely unable to effect change in unsaturated soils.	Easy to implement. Monitoring of unsaturated soil would require repeated intrusive sampling events. Implementation would likely be ineffective.	Moderate costs for monitoring.	Not retained because ineffective with Site contaminants and conditions (i.e., shallow unsaturated soil).
	Phytoremediation	Phytoremediation is a process that uses plants to remove, transfer, stabilize, and destroy contaminants in soil or sediment.	Can be effective at removing a variety of organic and inorganic compounds from soil through plant uptake in vicinity of roots (rhizosphere).	Requires significant land area suitable for large plants. Contamination must be accessible to plant root zones. Likely not compatible with anticipated future site use because plant management required not consistent with natural park.	Low to moderate implementation cost.	Although potentially suitable for some of the Site contaminants of concern, not suitable for long-term intended site use as a park.
EX SITU PHYSICAL/CHEMICAL/ THERMAL TREATMENT	Chemical Extraction	Excavated soil is mixed with an extractant, which dissolves the contaminants. The resultant solution is placed in a separator to remove the contaminant/extractant mixture for treatment.	Most suitable to removal of semi-volatile and inorganic contamination from excavated soil. Extracted solute/contaminants would be disposed of as a concentrated waste and treated soil could be reused as backfill.	Can be effective in removing most organic or soluble inorganic contaminants from soil. Difficult to remove all contaminant/extractant mixture from soil—would likely require finish treatment. Requires area for soil treatment or transport to off-site facility. Extractant fluid would need subsequent treatment process or disposal.	High implementation cost.	Not retained for excavated soil as significant additional cost over soil disposal with insufficient benefit (treatment costs higher than disposal costs).
	Solidification/ Stabilization	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization).	Potentially suitable to reduce leaching of contaminants prior to disposal.	Could be used to solidify wet soil or stabilize inorganics if needed for acceptance of excavated soil at the disposal facility. Successfully used on prior removal action at the site.	Low to Moderate implementation cost.	Retained as potentially applicable to soil fraction of excavated soil if stabilization has benefit for disposal.
	Dehalogenation	Reagents are added to soils contaminated with halogenated organics to remove halogen molecules.	Effective at detoxifying halogenated organic compounds in excavated soil. Not applicable to inorganics or non-halogenated COCs.	Requires mixing of reagents (in on-site process or off-site plant). Likely requires further treatment or disposal of processed soil.	Moderate to high implementation cost.	Not retained because incompatible with Site contaminants.
	Incineration	High temperatures are used to combust (in the presence of oxygen) organic constituents in hazardous wastes.	Effective at removing organic contaminants from excavated soil. Not applicable to inorganics (though can change the oxidative state).	Requires transport to off-site facility (long-distance interstate transport—nearest facility in Nebraska, distance of 1,200 miles). Not applicable to site contaminants.	High implementation cost.	Not retained because incompatible with Site contaminants.
	Soil Washing	Contaminants are separated from the excavated soil with wash-water augmented with additives to help remove organics.	Most suitable to removal of semi-volatile and inorganic contamination from excavated soil. Extracted solute/contaminants would be disposed of as a concentrated waste and treated soil could be reused as backfill.	Requires area for soil treatment or transport to off-site facility. Resultant fluid would need subsequent treatment process or disposal.	Moderate to high implementation cost.	Not retained for excavated soil as significant additional cost over soil disposal with insufficient benefit (treatment costs higher than disposal costs).
	Solar Detoxification	Contaminants are destroyed by photochemical and thermal reactions using ultraviolet energy in sunlight or artificial UV light. Usually involves application of catalyst agent.	Can be effective at treating a variety of organic compounds. Not applicable to inorganics.	Implementation with sunlight limited by availability (not effective during nighttime and limited effectiveness in cloudy/wet seasons). Not applicable to site contaminants.	Low to moderate implementation cost.	Not retained because incompatible with Site contaminants. Long-term process not compatible with anticipated future site use during implementation.
	Thermal Desorption/ Pyrolysis/ Hot Gas Decontamination	Waste soils are heated to either volatilize (desorption and hot gas) or to anaerobically decompose (pyrolysis) organic contaminants. Off-gas is collected and treated.	Effective at removing organic materials from excavated soil (particularly volatile organics). Pyrolysis generally used for semi-volatiles or pesticide wastes. Would not be effective for inorganics.	Not applicable to treatment of inorganic contaminants.	Moderate to high implementation cost.	Not retained for excavated soil as incompatible with inorganic COCs and significant additional cost over soil disposal with insufficient benefit (treatment costs higher than disposal costs).

Please refer to note at end of table.

Table 3
Initial Screening and Evaluation of Technologies for Soil
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

General Response Actions	Technology	Description	Screening Criteria			Screening Comments
			Effectiveness	Implementability	Cost	
EX SITU PHYSICAL/ CHEMICAL/ THERMAL TREATMENT—CONTINUED	Separation	Separation techniques concentrate contaminated solids through physical, magnetic, and/or chemical means. These processes remove solid-phase contaminants from the soil matrix.	Effective for removal of solids with distinct physical characteristics (size, composition, etc.).	Commercial equipment available for separation by size (sieving) or for removing iron (magnetic removal).	Low to moderate cost.	May be potentially applicable for removal of rock fraction and debris from excavated soil prior to offsite disposal (reducing disposal volume). Not expected to directly separate contaminants.
EX SITU BIOLOGICAL TREATMENT	Biopiles	Excavated soils are mixed with soil amendments and placed in aboveground enclosures and aerated with blowers or vacuum pumps.	Effective for removal of organic contaminants from excavated soil. Would not be effective for inorganics and organic COCs would likely react slowly to process.	Not applicable to treatment of inorganic contaminants.	Low to moderate cost.	Not retained because incompatible with Site contaminants. Long-term process not compatible with anticipated future site use during implementation.
	Composting	Excavated soil is mixed with bulking agents and organic amendments to promote microbial activity.	Effective for removal of organic contaminants from excavated soil. Would not be effective for inorganics and organic COCs would likely react slowly to process.	Not applicable to treatment of inorganic contaminants.	Low to moderate cost.	Not retained because incompatible with Site contaminants. Long-term process not compatible with anticipated future site use during implementation.
	Landfarming	Excavated soil is placed in lined beds and periodically tilled to aerate the soil.	Effective for removal of organic contaminants from excavated soil. Would not be effective for inorganics and organic COCs would likely react slowly to process.	Not applicable to treatment of inorganic contaminants.	Low to moderate cost.	Not retained because incompatible with Site contaminants. Long-term process not compatible with anticipated future site use during implementation.
	Slurry Phase Biological Treatment	An aqueous slurry of soil, sediment, or sludge with water and other additives is mixed to keep solids suspended and microorganisms in contact with the soil contaminants. When complete, the slurry is dewatered and the soil is disposed of.	Effective for removal of organic contaminants from excavated soil. Would not be effective for inorganics and organic COCs would likely react slowly to process.	Not applicable to treatment of inorganic contaminants. Would require significant infrastructure for treatment and management of soil volume.	Moderate to high implementation cost.	Not retained because incompatible with Site contaminants. Long-term process not compatible with anticipated future site use during implementation.

Note:
1. Shading indicates technology has been eliminated from consideration.

Table 4
Cost Table – Cap
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

Alternative Component	Units	Unit Cost	Extension	Notes
Capital				
Design, Permitting, and Procurement				
Work Plan Preparation	1 LS	\$20,000 /each	\$20,000	For DEQ review and approval
Survey	19 ac	\$3,600 /ac	\$68,400	Pre-design topographic survey (Means) Assume public bid; 8 design sheets at \$5,000 per sheet plus \$15,000 for
Drawings and Specifications	1 LS	\$55,000 /each	\$55,000	Port Engineering
Permitting	1 LS	\$20,000 /each	\$20,000	Professional judgment
Procurement/Contracting	1 LS	\$15,000 /each	\$15,000	Professional judgment
Soil Management Plan/Institutional Controls	1 LS	\$20,000 /each	\$20,000	Professional judgment
Design and Procurement Subtotal			\$198,000	
Construction				
Utility Locating	24 hr	\$70 /hr	\$1,700	Unit rate from recent subcontract
Mobilization	1 LS	\$263,970 /each	\$264,000	Assume 10% construction total; includes contractor work plans
Access Road Improvements	1,420 sy	\$20.60 /sy	\$29,300	4-inch overlay (Means) along N Edgewater Ave
Erosion Control	4,500 lf	\$1.06 /foot	\$4,800	Means
Construction Entrance	1 LS	\$1,500 /each	\$1,500	25 x 60 rock construction entrance (per City req's)
Erosion Control Maintenance	8 months	\$630 /month	\$5,100	10% of Erosion Control and Construction Entrance
Dust Control	100 day	\$400 /day	\$40,000	Water truck/driver (Means); purchase water from City (0.5 gal/sy/hr)
Survey Control	19 ac	\$2,200 /ac	\$41,800	Means
Site Clearing (forested)	9.5 ac	\$6,200 /ac	\$58,900	Means (cut and chip trees, close-cut stumps)
Site Clearing (unforested)	9.5 ac	\$920 /ac	\$8,800	Means (shrub/brush mowing)
Site Grading	19 ac	\$2,100 /ac	\$39,900	Means
Purchase/Deliver Topsoil for Cap (6 inches)	25,000 ton	\$22.61 /ton	\$565,300	Means
Purchase/Deliver Import Fill for Cap (18 inches)	75,000 ton	\$12.40 /ton	\$930,000	Means
Place and Compact	62,000 cy	\$6.13 /cy	\$380,100	Means
Re-Vegetation (forested)	9.5 ac	\$41,000 /ac	\$389,500	Means; hydroseeding, trees @ 20' spacing, shrubs @ 6' spacing
Re-Vegetation (unforested)	9.5 ac	\$2,700 /ac	\$25,700	Means; hydroseeding, includes placement of mulch
Temporary Irrigation System	9.5 ac	\$6,560 /ac	\$62,400	Temporary Drip System for trees and shrubs; cost from similar project
First Year of Irrigation	9 months	\$6,100 /month	\$54,900	Water truck/driver (Means); purchase water from City
Overhead, bonding, insurance	1 LS	\$290,370 /each	\$290,400	Assume 10% of construction - professional judgment
Construction Subtotal			\$3,195,000	
Oversight and Reporting				
Construction Management	120 day	\$500 /day	\$60,000	Professional judgment
Engineering Oversight	120 day	\$1,500 /day	\$180,000	Assume 15 cy trucks, 10 minutes per truck, 8 hour days, plus prep
Report	1 LS	\$20,000 /each	\$20,000	Professional judgment
Agency Oversight (DEQ/EPA)	10 %	\$390,000 /each	\$39,000	Assumed 10% of engineering costs
Oversight and Reporting Subtotal			\$299,000	
Long-Term (Net Present Value)				
Cap Inspection and Maintenance	5 yr	\$13,101 /yr	\$60,900	Assume net discount rate of 2.5% for present-worth calculations. Assume 1% of cap installation cost
Plant Inspection and Replacement/Control	5 yr	\$20,760 /yr	\$96,500	Assume 5% of plant installation cost
Long-Term Annual Inspections	25 yr	\$3,800 /yr	\$70,100	Inspections only years 5 through 30 (w/ summary letter)
Long-Term Subtotal (Net Present Value)			\$228,000	
Contingency				
Contingency	15 %	\$3,920,000	\$588,000	Professional judgment
Total			Total \$4,510,000	

Notes:

- 1) Means - 2014 RS Means Online Cost Estimating

Table 5
Cost Table – Excavate and Off-Site Disposal
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

Alternative Component	Units	Unit Cost	Extension	Notes
Capital				
Design, Permitting, and Procurement				
Work Plan Preparation	1 LS	\$20,000 /each	\$20,000	For DEQ review and approval
Survey	19 ac	\$3,600 /ac	\$68,400	Pre-design topographic survey (Means)
Drawings and Specifications	1 LS	\$45,000 /each	\$45,000	Assume public bid; 6 design sheets at \$5,000 per sheet plus \$15,000 for Port Engineering
Permitting	1 LS	\$30,000 /each	\$30,000	Professional judgment
Procurement/Contracting	1 LS	\$15,000 /each	\$15,000	Professional judgment
Design and Procurement Subtotal			\$178,000	
Construction				
Utility Locating	24 hr	\$70 /hr	\$1,700	Unit rate from recent subcontract
Mobilization	1 LS	\$521,000 /each	\$521,000	Assume 10% construction total (less disposal fees); includes contractor work plans
Access Road Improvements	1,420 sy	\$20.60 /sy	\$29,300	4-inch overlay (Means) along N Edgewater Ave
Erosion Control	4,500 lf	\$1.06 /foot	\$4,800	Means
Construction Entrance	1 LS	\$1,500 /each	\$1,500	25 x 60 rock construction entrance (per City req's)
Erosion Control Maintenance	12 months	\$630 /month	\$7,600	10% of Erosion Control and Construction Entrance
Dust Control	170 day	\$276 /day	\$47,000	Water truck/driver (Means); purchase water from City (0.5 gal/sy/hr)
Survey Control	19 ac	\$2,200 /ac	\$41,800	Means
Site Clearing (forested)	9.5 ac	\$9,330 /ac	\$88,700	Means (cut and chip trees, grub stumps)
Site Clearing (unforested)	9.5 ac	\$920 /ac	\$8,800	Means (shrub/brush mowing)
Soil Excavation and Load	92,000 cy	\$15 /cy	\$1,380,000	Means
Impacted Soil Waste Profiling				
Chemical Analyses (TCLP metals)	180 each	\$150 /each	\$27,000	1 sample per 500 cubic yards; Unit rate from lab price list
Waste Profiling Data Package	20 hr	\$125 /hr	\$2,500	Soil data compilation and prepare waste profile forms
Transport	160,000 ton	\$10 /ton	\$1,600,000	Assume 3 hr round trip; 30 ton/load; \$100/hr
Disposal	160,000 ton	\$30 /ton	\$4,800,000	Quote from Waste Management for Hillsboro Landfill
Confirmation Soil Sampling and Chemical Analyses	165 each	\$440 /each	\$72,600	Assume one sample per 100 linear feet perimeter; one sample per 5000 sf bottom; analyze for total metals and PAHs (10% of samples for dioxins and PCBs); Unit rate from lab price list
Imported Topsoil (material and transport)	52,000 ton	\$22.61 /ton	\$1,175,800	Means
Place and Compact	31,000 cy	\$6.13 /cy	\$190,100	Means
Re-Vegetation (forested)	9.5 ac	\$41,000 /ac	\$389,500	Means; hydroseeding, trees @ 20' spacing, shrubs @ 6' spacing
Re-Vegetation (unforested)	9.5 ac	\$2,700 /ac	\$25,700	Means; hydroseeding, includes placement of mulch
Temporary Irrigation System	9.5 ac	\$6,560 /ac	\$62,400	Temporary Drip System for trees and shrubs; cost from similar project
First Year of Irrigation	9 months	\$6,100 /month	\$54,900	Water truck/driver (Means); purchase water from City
Overhead, bonding, insurance	1 LS	\$1,053,270 /each	\$1,053,300	Assume 10% of construction - professional judgment
Construction Subtotal			\$11,586,000	
Oversight and Reporting				
Construction Management	190 day	\$500 /day	\$95,000	Professional judgment
Engineering Oversight	190 day	\$1,500 /day	\$285,000	Assume 15 cy trucks, 10 minutes per truck, 8 hour days, plus prep
Report	1 LS	\$20,000 /each	\$20,000	Professional judgment
Agency Oversight (DEQ/EPA)	10 %	\$510,000 /each	\$51,000	Assumed 10% of engineering costs
Oversight and Reporting Subtotal			\$451,000	
Long-Term (Net Present Worth)				
Plant Inspection and Replacement/Control	5 yr	\$20,760 /yr	\$96,500	Assume net discount rate of 2.5% for present-worth calculations. Assume 5% of plant installation cost
Long-Term Annual Inspections	25 yr	\$3,800 /yr	\$70,100	Inspections only years 5 through 30 (w/ summary letter)
Long-Term Subtotal (Net Present Worth)			\$167,000	
Contingency				
Contingency	15 %	\$12,382,000	\$1,858,000	Professional judgment
Total			Total \$14,240,000	

Notes:

- 1) Means - 2014 RS Means Online Cost Estimating

Table 6
Cost Table – Excavate and On-Site Disposal
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

Alternative Component	Units	Unit Cost	Extension	Notes
Capital				
Design, Permitting, and Procurement				
Work Plan Preparation	1 LS	\$30,000 /each	\$30,000	For DEQ review and approval
Survey	19 ac	\$3,600 /ac	\$68,400	Pre-design topographic survey (Means)
Drawings and Specifications	1 LS	\$65,000 /each	\$65,000	Assume public bid; 10 design sheets at \$5,000 per sheet plus \$15,000 for Port Engineering
Permitting	1 LS	\$25,000 /each	\$25,000	Professional judgment
Procurement/Contracting	1 LS	\$20,000 /each	\$20,000	Professional judgment
Soil Management Plan/Institutional Controls	1 LS	\$20,000 /each	\$20,000	Professional judgment
Design and Procurement Subtotal			\$228,000	
Construction				
Utility Locating	24 hr	\$70 /hr	\$1,700	Unit rate from recent subcontract
Mobilization	1 LS	\$413,710 /each	\$413,800	Assume 10% construction total; includes contractor work plans
Access Road Improvements	1,420 sy	\$20.60 /sy	\$29,300	4-inch overlay (Means) along N Edgewater Ave
Erosion Control	4,500 lf	\$1.06 /foot	\$4,800	Means
Construction Entrance	1 LS	\$1,500 /each	\$1,500	25 x 60 rock construction entrance (per City req's)
Erosion Control Maintenance	9 months	\$630 /month	\$5,700	10% of Erosion Control and Construction Entrance
Dust Control	110 day	\$276 /day	\$30,400	Water truck/driver (Means); purchase water from City (0.5 gal/sy/hr)
Survey Control	19 ac	\$2,200 /ac	\$41,800	Means
Site Clearing (forested)	9.5 ac	\$9,330 /ac	\$88,700	Means (cut and chip trees, grub stumps)
Site Clearing (unforested)	9.5 ac	\$920 /ac	\$8,800	Means (shrub/brush mowing)
Soil Excavation and Load	68,000 cy	\$15 /cy	\$1,020,000	Means
Transport/Pile	68,000 cy	\$8.61 /cy	\$585,500	Means
Confirmation Soil Sampling and Chemical Analyses	125 each	\$440 /each	\$55,000	Assume one sample per 5000 sf bottom; analyze for total metals and PAHs (10% of samples for dioxins and PCBs); Unit rate from lab price list
Construction Subtotal			\$5,006,000	
Oversight and Reporting				
Construction Management	130 day	\$500 /day	\$65,000	Professional judgment
Engineering Oversight	130 day	\$1,500 /day	\$195,000	Assume 15 cy trucks, 10 min/truck, 8 hr days
Report	1 LS	\$20,000 /each	\$20,000	Professional judgment
Agency Oversight (DEQ/EPA)	10 %	\$440,000 /each	\$44,000	Assumed 10% of engineering costs
Oversight and Reporting Subtotal			\$324,000	
Long-Term (Net Present Worth)				
Cap Inspection and Maintenance	5 yr	\$23,169 /yr	\$107,700	Assume net discount rate of 2.5% for present-worth calculations. Assume 1% of cap installation cost
Plant Inspection and Replacement/Control	5 yr	\$20,760 /yr	\$96,500	Assume 5% of plant installation cost
Long-Term Annual Inspections	25 yr	\$3,800 /yr	\$70,100	Inspections only years 5 through 30 (w/ summary letter)
Long-Term Subtotal (Net Present Worth)			\$274,000	
Contingency				
Contingency	15 %	\$5,832,000	\$875,000	Professional judgment
Total			Total \$6,710,000	

Notes:

- 1) Means - 2014 RS Means Online Cost Estimating

Table 7

Cost Table – Focused Excavation and Off-Site Disposal with Cap
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

Alternative Component	Units	Unit Cost	Extension	Notes
Capital				
Design, Permitting, and Procurement				
Design Investigation	1 LS	\$100,000 /each	\$100,000	Better define hot spots
Work Plan Preparation	1 LS	\$30,000 /each	\$30,000	For DEQ review and approval
Survey	19 ac	\$3,600 /ac	\$68,400	Pre-design topographic survey (Means)
Drawings and Specifications	1 LS	\$65,000 /each	\$65,000	Assume public bid; 10 design sheets at \$5,000 per sheet plus \$15,000 for Port Engineering
Permitting	1 LS	\$25,000 /each	\$25,000	Professional judgment
Procurement/Contracting	1 LS	\$20,000 /each	\$20,000	Professional judgment
Soil Management Plan/Institutional Controls	1 LS	\$20,000 /each	\$20,000	Professional judgment
Design and Procurement Subtotal			\$328,000	
Construction				
Utility Locating	24 hr	\$70 /hr	\$1,700	Unit rate from recent subcontract
Mobilization	1 LS	\$308,000 /each	\$308,000	Assume 10% construction total (less disposal fees); includes contractor work plans
Access Road Improvements	1,420 sy	\$20.60 /sy	\$29,300	4-inch overlay (Means) along N Edgewater Ave
Erosion Control	4,500 lf	\$1.06 /foot	\$4,800	Means
Construction Entrance	1 LS	\$1,500 /each	\$1,500	25 x 60 rock construction entrance (per City req's)
Erosion Control Maintenance	9 months	\$630 /month	\$5,700	10% of Erosion Control and Construction Entrance
Dust Control	120 day	\$400 /day	\$48,000	Water truck/driver (Means); purchase water from City (0.5 gal/sy/hr)
Survey Control	19 ac	\$2,200 /ac	\$41,800	Means
Excavation Site Clearing (forested)	1.3 ac	\$9,330 /ac	\$12,200	Means (cut and chip trees, grub stumps); 50% of excavation area
Cap Site Clearing (forested)	8.2 ac	\$6,200 /ac	\$50,900	Means (cut and chip trees, close-cut stumps)
Site Clearing (unforested)	9.5 ac	\$920 /ac	\$8,800	Means (shrub/brush mowing)
Soil Excavation and Load	13,000 cy	\$15 /cy	\$195,000	Unit rate estimated from Means Cost Guide
Impacted Soil Waste Profiling				
Chemical Analyses (TCLP metals)	26 each	\$150 /each	\$3,900	1 sample per 500 cubic yards; Unit rate from lab price list
Waste Profiling Data Package	16 hr	\$125 /hr	\$2,000	Soil data compilation and prepare waste profile forms
Transport	21,000 ton	\$10 /ton	\$210,000	Assume 3 hr round trip; 30 ton/load; \$100/hr
Disposal	21,000 ton	\$30 /ton	\$630,000	Quote from Waste Management for Hillsboro Landfill
Confirmation Soil Sampling and Chemical Analyses	65 each	\$255 /each	\$16,600	Assume one sample per 100 lineal feet of perimeter and one sample per 5000 sf bottom; analyze for total metals (20% of samples for PAHs and 10% of samples for dioxins and PCBs); Unit rate from lab price list
Site Grading	19 ac	\$2,100 /ac	\$39,900	Means
Purchase/Deliver Topsoil for Cap (6 inches)	25,000 ton	\$22.61 /ton	\$565,300	Means
Purchase/Deliver Import Fill for Cap (18 inches)	75,000 ton	\$12.40 /ton	\$930,000	Means
Place and Compact	62,000 cy	\$6.13 /cy	\$380,100	Means
Re-Vegetation (forested)	9.5 ac	\$41,000 /ac	\$389,500	Means; hydroseeding, trees @ 20' spacing, shrubs @ 6' spacing
Re-Vegetation (unforested)	9.5 ac	\$2,700 /ac	\$25,700	Means; hydroseeding, includes placement of mulch
Temporary Irrigation System	9.5 ac	\$6,560 /ac	\$62,400	Temporary Drip System for trees and shrubs; cost from similar project
First Year of Irrigation	9 months	\$6,100 /month	\$54,900	Water truck/driver (Means); purchase water from City
Overhead, bonding, insurance	1 LS	\$401,800 /each	\$401,800	Assume 10% of construction - professional judgment
Construction Subtotal			\$4,420,000	
Oversight and Reporting				
Construction Management	140 day	\$500 /day	\$70,000	Professional judgment
Engineering Oversight	140 day	\$1,500 /day	\$210,000	Assume 15 cy trucks, 10 min/truck, 8 hr days
Report	1 LS	\$20,000 /each	\$20,000	Professional judgment
Agency Oversight (DEQ/EPA)	10 %	\$530,000 /each	\$53,000	Assumed 10% of engineering costs
Oversight and Reporting Subtotal			\$353,000	
Long-Term (Net Present Value)				
Cap Inspection and Maintenance	5 yr	\$13,101 /yr	\$60,900	Assume net discount rate of 2.5% for present-worth calculations.
Plant Inspection and Replacement/Control	5 yr	\$20,760 /yr	\$96,500	Assume 1% of cap installation cost
Long-Term Annual Inspections	25 yr	\$3,800 /yr	\$70,100	Assume 5% of plant installation cost
Long-Term Subtotal (Net Present Value)			\$228,000	Inspections only years 5 through 30 (w/ summary letter)
Contingency				
Contingency	25 %	\$5,329,000	\$1,333,000	Professional judgment
Total				
Total			\$6,662,000	

Notes:

- 1) Means - 2014 RS Means Online Cost Estimating

Table 8

Cost Table – Focused Excavation and Off-Site Disposal with Alternate Cap and Access Restriction
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

Alternative Component	Units	Unit Cost	Extension	Notes
Capital				
Design, Permitting, and Procurement				
Design Investigation	1 LS	\$100,000 /each	\$100,000	Better define hot spots
Work Plan Preparation	1 LS	\$20,000 /each	\$20,000	For DEQ review and approval
Drawings and Specifications	1 LS	\$55,000 /each	\$55,000	Assume public bid; 8 design sheets at \$5,000 per sheet plus \$15,000 for Port Engineering
Permitting	1 LS	\$20,000 /each	\$20,000	Professional judgment
Procurement/Contracting	1 LS	\$15,000 /each	\$15,000	Professional judgment
Soil Management Plan/Institutional Controls	1 LS	\$30,000 /each	\$30,000	Professional judgment
Design and Procurement Subtotal			\$240,000	
Construction				
Utility Locating	24 hr	\$70 /hr	\$1,700	Unit rate from recent subcontract
Mobilization	1 LS	\$111,400 /each	\$111,400	Assume 10% construction total (less disposal fees); includes contractor work plans
Access Road Improvements	1,420 sy	\$20.60 /sy	\$29,300	4-inch overlay (Means) along N Edgewater Ave
Erosion Control	4,500 lf	\$1.06 /foot	\$4,800	Means
Construction Entrance	1 LS	\$1,500 /each	\$1,500	25 x 60 rock construction entrance (per City req's)
Erosion Control Maintenance	6 months	\$630 /month	\$3,800	10% of Erosion Control and Construction Entrance
Dust Control	40 day	\$400 /day	\$16,000	Water truck/driver (Means); purchase water from City (0.5 gal/sy/hr)
Survey Control	19 ac	\$2,200 /ac	\$41,800	Means
Excavation Site Clearing (forested)	1.3 ac	\$9,330 /ac	\$12,200	Means (cut and chip trees, grub stumps); 50% of excavation area
Site Clearing (Cap Area: non-forested Excavation)	7.9 ac	\$920 /ac	\$7,300	Means (shrub/brush mowing)
Soil Excavation and Load	13,000 cy	\$15 /cy	\$195,000	Unit rate estimated from Means Cost Guide
Impacted Soil Waste Profiling				
Chemical Analyses (TCLP arsenic)	26 each	\$150 /each	\$3,900	1 sample per 500 cubic yards; Unit rate from lab price list
Waste Profiling Data Package	16 hr	\$125 /hr	\$2,000	Soil data compilation and prepare waste profile forms
Transport	21,000 ton	\$10 /ton	\$210,000	Assume 3 hr round trip; 30 ton/load; \$100/hr
Disposal	21,000 ton	\$30 /ton	\$630,000	Quote from Waste Management for Hillsboro Landfill
Confirmation Soil Sampling and Chemical Analyses	65 each	\$255 /each	\$16,600	Assume one sample per 100 lineal feet of perimeter and one sample per 5000 sf bottom; analyze for total metals (20% of samples for PAHs and 10% of samples for dioxins and PCBs); Unit rate from lab price list
Site Grading	9 ac	\$2,100 /ac	\$19,400	Means
Purchase/Deliver Topsoil	9,000 ton	\$22.61 /ton	\$203,500	Means
Place and Compact	5,300 cy	\$6.13 /cy	\$32,500	Means
Re-Vegetation (forested)	1.3 ac	\$41,000 /ac	\$53,300	Means; hydroseeding, trees @ 20' spacing, shrubs @ 6' spacing
Re-Vegetation (shrubs)	7.9 ac	\$21,200 /ac	\$167,500	Means; hydroseeding, shrubs @ 6' spacing
Temporary Irrigation System	9.2 ac	\$6,560 /ac	\$60,400	Temporary Drip System for trees and shrubs; cost from similar project
First Year of Irrigation	9 months	\$3,500 /month	\$31,500	Water truck/driver (Means); purchase water from City
Overhead, bonding, insurance	1 LS	\$185,540 /each	\$185,600	Assume 10% of construction - professional judgment
Construction Subtotal			\$2,041,000	
Oversight and Reporting				
Construction Management	50 day	\$500 /day	\$25,000	Professional judgment
Engineering Oversight	50 day	\$1,500 /day	\$75,000	Assume 15 cy trucks, 10 min/truck, 8 hr days
Report	1 LS	\$20,000 /each	\$20,000	Professional judgment
Agency Oversight (DEQ/EPA)	10 %	\$340,000 /each	\$34,000	Assumed 10% of engineering costs
Oversight and Reporting Subtotal			\$154,000	
Long-Term (Net Present Value)				
Plant Inspection and Replacement/Control	5 yr	\$11,040 /yr	\$51,300	Assume net discount rate of 2.5% for present-worth calculations. Assume 5% of plant installation cost
Long-Term Subtotal (Net Present Value)			\$51,000	
Contingency				
Contingency	25 %	\$2,486,000	\$622,000	Professional judgment
Total			Total \$3,108,000	

Notes:

- 1) Means - 2014 RS Means Online Cost Estimating

Table 9
Cost Table – Alternate Cap and Access Restriction
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

Alternative Component	Units	Unit Cost	Extension	Notes
Capital				
Design, Permitting, and Procurement				
Design Investigation	1 LS	\$100,000 /each	\$100,000	Better define hot spots
Work Plan Preparation	1 LS	\$20,000 /each	\$20,000	For DEQ review and approval
Drawings and Specifications	1 LS	\$45,000 /each	\$45,000	Assume public bid; 6 design sheets at \$5,000 per sheet plus \$15,000 for Port Engineering
Permitting	1 LS	\$20,000 /each	\$20,000	Professional judgment
Procurement/Contracting	1 LS	\$15,000 /each	\$15,000	Professional judgment
Soil Management Plan/Institutional Controls	1 LS	\$30,000 /each	\$30,000	Professional judgment
Design and Procurement Subtotal			\$230,000	
Construction				
Utility Locating	8 hr	\$70 /hr	\$600	Unit rate from recent subcontract
Mobilization	1 LS	\$63,500 /each	\$63,500	Assume 10% construction total; includes contractor work plans
Access Road Improvements	1,420 sy	\$20.60 /sy	\$29,300	4-inch overlay (Means) along N Edgewater Ave
Erosion Control	4,500 lf	\$1.06 /foot	\$4,800	Means
Construction Entrance	1 LS	\$1,500 /each	\$1,500	25 x 60 rock construction entrance (per City req's)
Erosion Control Maintenance	5 months	\$630 /month	\$3,200	10% of Erosion Control and Construction Entrance
Dust Control	20 day	\$400 /day	\$8,000	Water truck/driver (Means); purchase water from City (0.5 gal/sy/hr)
Survey Control	19 ac	\$2,200 /ac	\$41,800	Means
Site Clearing (Cap Area)	6.6 ac	\$920 /ac	\$6,100	Means (shrub/brush mowing)
Site Grading	6.6 ac	\$2,100 /ac	\$13,900	Means
Purchase/Deliver Topsoil	12,000 ton	\$22.61 /ton	\$271,400	Means
Place and Compact	6,900 cy	\$6.13 /cy	\$42,300	Means
Re-Vegetation (shrubs)	6.6 ac	\$21,200 /ac	\$140,000	Means; hydroseeding, shrubs @ 6' spacing
Temporary Irrigation System	6.6 ac	\$6,560 /ac	\$43,300	Temporary Drip System for shrubs; cost from similar project
First Year of Irrigation	9 months	\$3,200 /month	\$28,800	Water truck/driver (Means); purchase water from City
Overhead, bonding, insurance	1 LS	\$69,850 /each	\$69,900	Assume 10% of construction - professional judgment
Construction Subtotal			\$769,000	
Oversight and Reporting				
Construction Management	40 day	\$500 /day	\$20,000	Professional judgment
Engineering Oversight	40 day	\$1,500 /day	\$60,000	Assume 15cy trucks, 10 min/truck, 8 hr days
Report	1 LS	\$20,000 /each	\$20,000	Professional judgment
Agency Oversight (DEQ/EPA)	10 %	\$310,000 /each	\$31,000	Assumed 10% of engineering costs
Oversight and Reporting Subtotal			\$131,000	
Long-Term (Net Present Value)				
Plant Inspection and Replacement/Control	5 yr	\$7,000 /yr	\$32,600	Assume net discount rate of 2.5% for present-worth calculations. Assume 5% of plant installation cost
Long-Term Subtotal (Net Present Value)			\$33,000	
Contingency				
Contingency	25 %	\$1,163,000	\$291,000	Professional judgment
Total				
			Total	\$1,454,000

Notes:

- 1) Means - 2014 RS Means Online Cost Estimating

Table 10
Comparative Evaluation of Alternatives
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

Release Area Alternative	Protective	Balancing Factors																								Score	Rank				
		Effectiveness						Long-Term Reliability						Implementability						Implementation Risk								Reasonableness of Cost			
		A	B	C	D	E	F	G	A	B	C	D	E	F	G	A	B	C	D	E	F	G	A	B	C	D	E	F	G		
A) No Action	No	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	-	+	+	+	+	+	+	6	na
B) Cap	Yes	+	-	-	-	-	-	+	+	-	-	-	-	-	+	-	-	+	-	+	-	-	-	-	+	-	+	-	-	-10	6
C) Excavation and Off-Site Disposal	Yes	+	+	-	+	+	+	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-6	4
D) Excavation and On-Site Disposal	Yes	+	+	-	-	-	-	+	+	+	-	-	-	-	+	-	+	+	-	+	-	-	-	+	+	-	+	-	-	0	3
E) Focused Excavation and Offsite Disposal with Cap	Yes	+	+	-	+	-	0	+	+	+	-	+	-	-	+	-	-	+	-	-	-	-	-	-	+	-	+	-	-	-7	5
F) Focused Excavation and Offsite Disposal with Alternate Cap and Access Restriction	Yes	+	+	-	+	0	-	+	+	+	-	+	+	-	+	-	+	+	+	+	-	-	-	+	+	+	+	-	-	13	1
G) Alternate Cap and Access Restriction	Yes	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	+	+	+	+	+	-	-	+	+	+	+	+	+	4	2

Notes:

- + = The alternative is favored over the compared alternative (score=1)
- 0 = The alternative is equal with the compared alternative (score=0)
- = The alternative is less favorable than the compared alternative (score=-1)
- na = Not protective, therefore not ranked

Technology	A	B	C	D	E	F	G
Technology A	-	-	-	-	-	-	-
Technology B	+	-	-	-	-	-	-
Technology C	+	+	-	-	-	-	-
Technology D	+	+	+	-	-	-	-
Technology E	+	+	+	+	-	-	-
Technology F	+	+	+	+	+	-	-
Technology G	+	+	+	+	+	+	-